Small Animal Dentistry

A manual of techniques

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This book is dedicated to my parents Leslie and Rona Tutt who did not spare anything in allowing us to develop into the people we are today, and to my wife Kim whose love I cherish.

In reviewing dental embryology and development I have once again come to realise the intricate way in which our bodies have been constructed and reaffirm that there is a God who commands our belief in Him.

Contents

Acknowledgements

I was introduced to veterinary dentistry as an undergraduate student by Dr Frank Verstraete and was subsequently able to pursue this interest during a seven year sojourn in the United Kingdom. During this time Drs Cecilia Gorrel and Judith Deeprose were instrumental in broadening my 'dentistry horizons' and they were a pleasure to work with. Veterinary dentistry is not a procedure that can be performed in isolation by the veterinary surgeon and I have had the privilege of working with a number of competent veterinary nurses. Kelly Young and Sue Vranch were extremely helpful to me especially during the early years when some procedures took longer than they do now! Numerous members of the British Veterinary Dental Association and the European Veterinary Dental Society and College have encouraged me through the years and their help has been appreciated. My rough sketches and descriptions have been converted into concise illustrations by Dr David Crossley, whose help is acknowledged.

I would like to thank Antonia Seymour for initiating this project and for her patience with its often delayed progress.

Kim, my wife, has helped me tirelessly. Her attention to detail kept me from being verbose and thanks to her your navigation through this book using the index will be a pleasure.

To the editorial and commissioning staff at Blackwell Publishing and their copy editor, my sincere thanks for your help, encouragement and keeping the project on track!

1 Tooth Development (Odontogenesis)

Dogs and cats have two sets of teeth, namely the primary or deciduous dentition, and the secondary or permanent dentition. The primary dentition develops during the embryonic and foetal stages, while the permanent dentition develops during the foetal and neonatal stages of development. Tooth development progresses through a number of stages.

Stages of tooth development

Initiation stage

Induction (an interaction between embryological tissues) is necessary for initiation to begin. The influence of mesenchymal tissues on ectodermal tissues is known as induction.

The primitive oral cavity is lined by ectoderm, the outer portion of which gives rise to the oral epithelium and is separated from the underlying mesenchyme (influenced by neural crest cells) by the basement membrane. The oral epithelium grows down into the mesenchyme giving rise to the dental lamina.

Bud stage

The dental lamina proliferates into the mesenchyme forming buds from which the teeth will develop. The mesenchyme also proliferates, still separated from the dental lamina by the basement membrane. All teeth develop from ectoderm and mesoderm which is influenced by neural crest cells.

Cap stage

Proliferation continues with differential growth of parts of the tooth bud leading to a cap shape. The predominant process during this stage is morphogenesis which determines the eventual shape of the tooth. Deep within the tooth bud the enamel organ develops, the inner layer of which will determine the crown shape. The enamel organ, which is of ectodermal origin, will produce enamel to cover the surface of the tooth crown. Within the confines of the cap the mesenchymal tissue forms the dental papilla from which the dentine and pulp will develop. The dental papilla remains separated from the enamel organ by the basement membrane. The dentino-enamel junction (DEJ) will develop in place of the basement membrane when it disintegrates. The mesenchyme surrounding the enamel organ forms the dental sac from which the periodontium will develop. The periodontium is thus of mesenchymal origin.

The three structures present at the end of the cap stage, namely the enamel organ, dental papilla and the dental sac, are collectively known as the tooth germ.

Bell stage

Proliferation, morphogenesis and differentiation continue. The cells of the enamel organ differentiate into four distinct layers:

(1) inner enamel (dental) epithelium which will differentiate into ameloblasts and produce enamel;

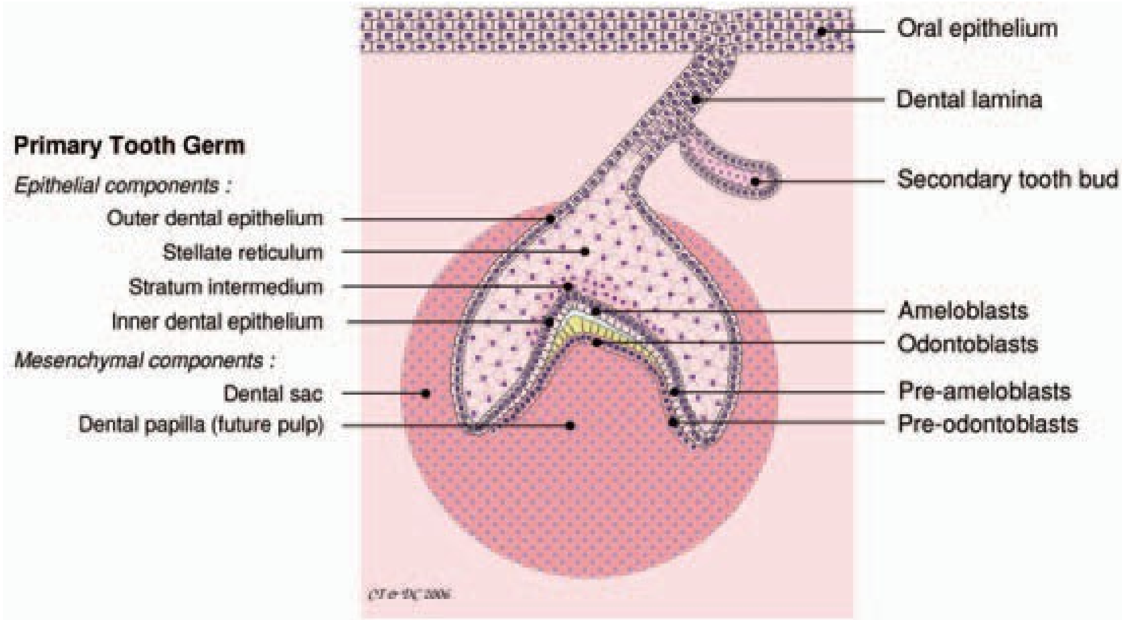


Figure 1.1 The tooth germ consists of the enamel organ, dental papilla and dental sac.

(2) stratum intermedium supporting enamel production;

(3) stellate reticulum supporting enamel production;

(4) outer enamel (dental) epithelium which protects the enamel organ during amelogenesis. (Figure 1.1)

The enamel organ is still separated from the dental papilla by the basement membrane.

Concurrently the dental papilla differentiates into two layers: the outermost layer will differentiate into odontoblasts and produce dentine while the inner layer will develop into the tooth pulp. The dental sac will differentiate into its separate tissues (gingiva, alveolus, periodontal ligament and cementum) at a later stage.

Apposition and maturation

During apposition, the matrices of enamel, dentine and cementum are laid down which will be mineralised into the final structures during maturation.

The developmental process

During the bell stage the inner enamel epithelium differentiates into pre-ameloblasts which induce the outer cells of the dental papilla to differentiate into odontoblasts which in turn secrete pre-dentine on their side of the basement membrane. At this stage the basement membrane separating the pre-ameloblasts and odontoblasts disintegrates. Contact with pre-dentine induces the pre-ameloblasts to develop into ameloblasts which begin amelogenesis, secreting enamel matrix, via Tome's process, onto the disintegrating basement membrane. The DEJ is formed by mineralisation of the disintegrated

basement membrane. Secretion of both dental matrices continues as the cells (odontoblasts and ameloblasts) retreat from the DEJ. The ameloblasts lose contact with the DEJ, but the odontoblasts retain contact via the odontoblastic process within the dentinal tubule. Odontoblasts remain vital within the pulp but ameloblasts are lost after tooth eruption.

Primary dentine is produced until apexogenesis (development of the tooth root apex) is complete. Secondary dentine is laid down from completion of apexogenesis throughout the life of the tooth. Under certain circumstances when the tooth is damaged, the pulp will be stimulated to produce tertiary or reparative dentine in an attempt to protect the pulp from exposure. Tertiary dentine is less structured than secondary dentine and becomes stained leading to black or brown spots usually in the centre of worn teeth surfaces. These discoloured spots must be differentiated from exposed, impacted pulp chambers and caries lesions.

The dentinal tubules are usually patent from the pulp to the dentino-enamel junction (DEJ) and dentino-cemental junctions and house the odontoblastic processes and sensory nerves. Exposed dentine can therefore cause severe pain and must be treated.

Root development

Once the crown is fully formed and begins to erupt into the mouth root development begins. The root is formed by the cervical loop which is the most apical portion of the original enamel organ and is comprised of the two epithelial layers (inner and outer enamel epithelium). The cervical loop grows down into the dental sac enclosing more of the dental papilla forming Hertwig's root sheath. Hertwig's root sheath determines the shape of the root/s and induces production of root dentine. Root and crown dentine are continuous, not separate, structures.

The inner enamel epithelial cell layer of Hertwig's root sheath induces the outer cells of the dental papilla to become odontoblasts which produce pre-dentine in a similar manner to that formed in the crown. After formation of root dentine, the basement membrane which has until now separated Hertwig's root sheath from the dental papilla, disintegrates along with Hertwig's root sheath. The remnants of Hertwig's root sheath are called the epithelial rests of Malassez which are located in the mature periodontal ligament (Figure 1.2). When stimulated, these cells may develop into cysts and require treatment. The root continues to develop until the apex is formed. The apical delta has numerous ramifications through which the pulp communicates with the periodontal ligament. Trauma to the immature tooth may cause pulpitis followed by pulp necrosis which will interfere with apexogenesis and may result in tooth death, requiring extraction. Damage to the developing root may cause an angulation of the root known as dilaceration.

Cementum

Undifferentiated cells of the dental sac are exposed to the root dentine when Hertwig's root sheath and the basement membrane disintegrate, inducing them to become cementoblasts. Cementoblasts secrete cementoid which contains cementocytes (cementoblasts which become trapped in the cementoid).

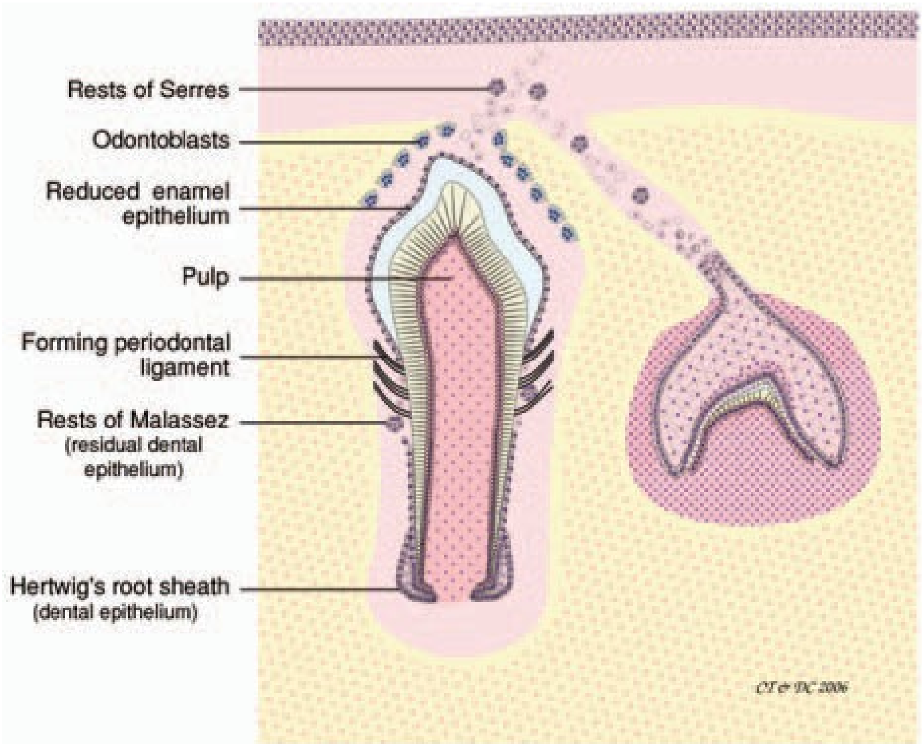


Figure 1.2 The root begins to develop when the tooth erupts into the mouth.

Cementoid undergoes mineralisation into cementum. Apposition of cementum on root dentine forms the dentino-cemental junction.

In man the cemento-enamel junction presents in one of three arrangements:

(1) in 60% of teeth cementum overlaps enamel

(2) in 30% cementum and enamel abut

(3) in 10% there is a gap between cementum and enamel.

In (3), exposed dentine leads to dentinal hypersensitivity which is painful. This can occur in some animals as well. Where dentine is exposed it should be sealed with an unfilled resin, varnish or sealant.

Hypercementosis is the production of excessive cementum on the apical third of the root. This can occur as a result of chronic inflammation and may complicate extractions in cats (Figure 1.3).

Periodontal ligament

The periodontal ligament withstands rotational and other forces applied to the tooth keeping it within the alveolus.

During crown and root development, mesenchyme from the surrounding dental sac begins to form the periodontal ligament and the tooth alveolus. Collagen fibres are formed which span the space between the cementum and the alveolar bone supporting the tooth within the alveolus. The periodontal ligament is made up of a number of fibre groups:

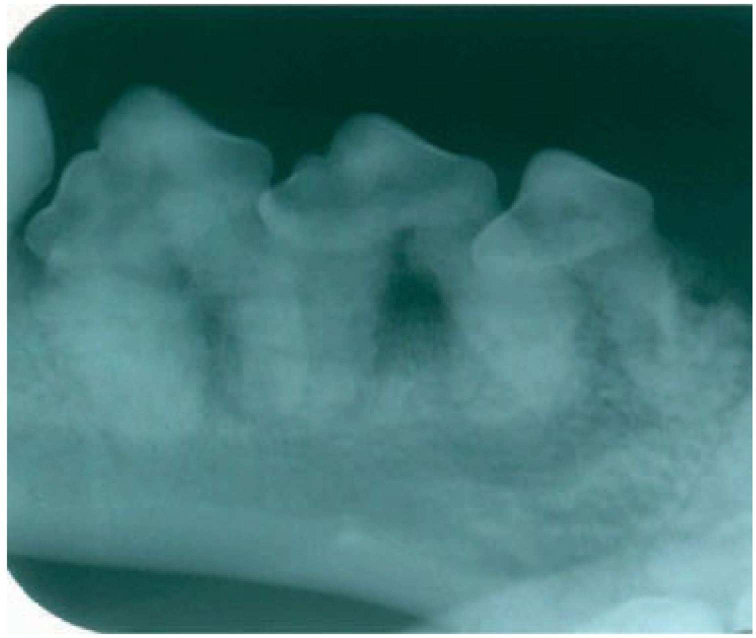


Figure 1.3 Dog mandibular right premolars affected by hypercementosis. Note the lack of periodontal ligament space.

(1) the alveolar crest group, which span the alveolar margin and the coronal part of the root, and which resist tilting, intrusion, extrusion and rotational forces;

(2) the horizontal group of fibres which span the coronal part of the root and the alveolus, which keep the tooth in a vertical position resisting tilting and rotational forces;

(3) the oblique group of fibres oriented margino-apically from the alveolus to the root surface preventing intrusion of the root and resisting rotational forces;

(4) the apical group which span apico-marginally from the alveolus on to the root, preventing extrusion of the root and resisting rotational forces.

In multi-rooted teeth inter-radicular (trans-furcation) fibres resist extrusion, intrusion, tilting and rotational forces (Figure 1.4).

What happens when things go wrong during tooth development?

Initiation stage

Anodontia (absence of teeth) or partial anodontia (hypodontia) results from failure of initiation. Supernumerary teeth are formed during initiation and may cause crowding (Figure 1.5). When crowding causes compromise of the normal teeth the supernumerary teeth should be extracted (Figure 1.6). Some breeds have developmental anomalies which result in abnormalities with the dentition. Most Chinese crested dogs have numerous missing teeth. This is an inherited condition rather than an idiopathic lack of initiation (Figure 1.7).

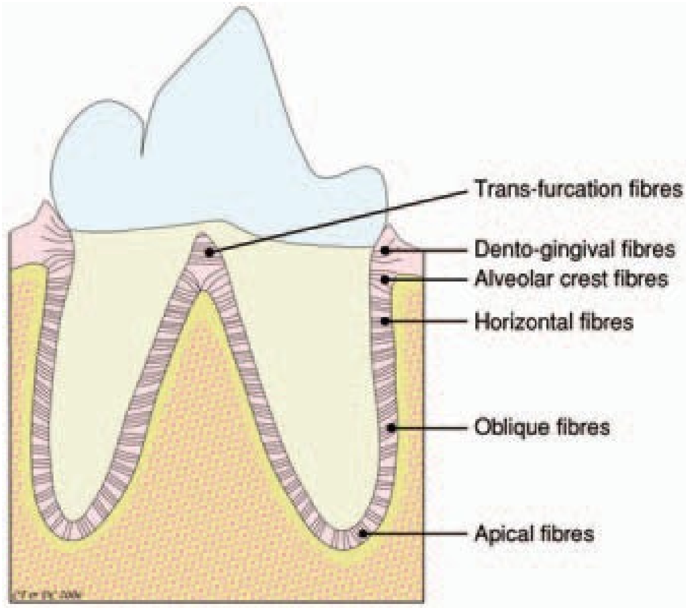


Figure 1.4 The periodontal ligament fibres keep the tooth in the alveolus and withstand: intrusive, extrusive, tipping and rotational forces.

Figure 1.5 Supernumerary mandibular right premolar 1 (405) in a dog. The tooth can be kept in this case as surrounding teeth are not compromised.

Bud stage

Macrodontia (abnormally large teeth) or microdontia (peg teeth) may occur.

Cap stage

Dens in dente. The enamel organ invaginates into itself, causing a tooth-like structure to develop within the tooth. This is rare in animals. This condition

Figure 1.6 Supernumerary mandibular left 4th premolar in a cat. The supernumerary tooth has exacerbated periodontal disease affecting surrounding teeth, necessitating extraction.

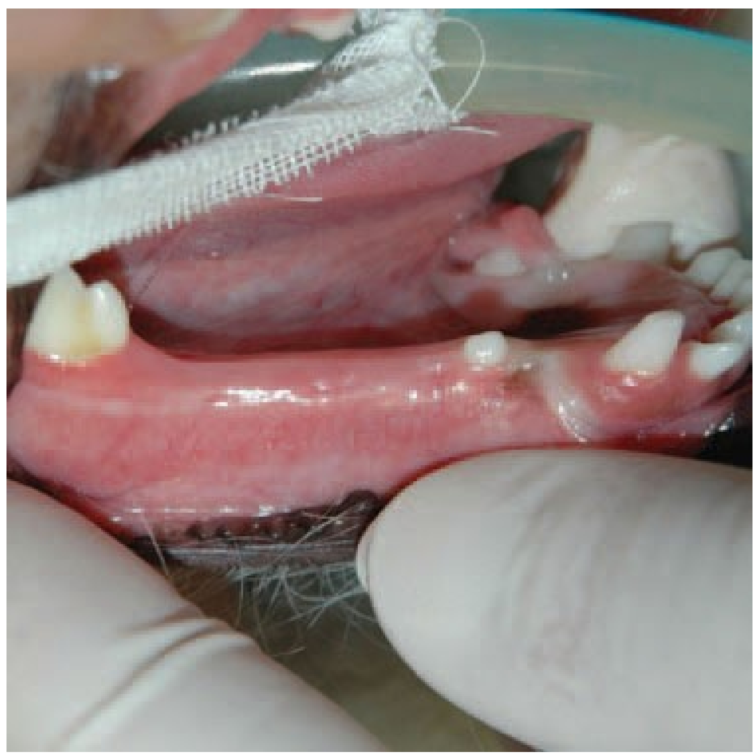


Figure 1.7 Hypodontia (partial anodontia) in a Chinese crested dog.

may be under diagnosed in animals due to infrequent use of radiography in veterinary dentistry.

Gemination is the complete or partial split of a single tooth bud resulting in a mirror-image crown, i.e. two crowns which are mirror images of each other (Figure 1.8). This gives the impression of an extra tooth in the affected

Figure 1.8 Gemination of mandibular right 4th premolar in a cat. The tooth bud has attempted to split to form two teeth.

Figure 1.9 Gemination of maxillary right incisor 2. There are four incisor crowns visible in the maxillary right quadrant.

quadrant and is most commonly seen in dog incisors (Figure 1.9). The root may also be partially or completely split (Figure 1.10).

Fusion is the union of two adjacent tooth buds resulting in one large tooth. The affected quadrant will have one less tooth (Figure 1.11).

Additional cusps (tubercles) are sometimes seen in man and in Spaniels.

Figure 1.10 Radiograph of case in Figure 1.9 showing almost complete separation of the roots in this divided tooth.

Figure 1.11 Fused maxillary left incisors 1 and 2 resulting in a large tooth and one less incisor in the maxillary left arcade.

Apposition and maturation

Enamel dysplasia. Enamel hypoplasia is a reduction in the quantity of enamel produced leading to pitting and grooves on the teeth, while enamel hypomineralisation results in reduced quality of enamel leading to discoloured teeth.

Figure 1.12 Malformed teeth in a dog suffering from Distemper Virus infection. Enamel hypoplasia is also present.

Figure 1.13 Enamel hypoplasia in a dog suffering from Distemper Virus infection. Note that the mandibular right deciduous canine and permanent premolar 1 are not affected. This is because these teeth were formed prior to the infection.

Dentine dysplasia may also occur. These conditions are often seen in dogs which have suffered from Distemper Virus infection and those which have suffered bouts of pyrexia during amelogenesis and dentinogenesis (Figures 1.12–1.15). The Distemper Virus can damage ameloblasts and

Figure 1.14 Enamel hypoplasia and dysplasia in a dog suffering from Distemper Virus infection. Note the severity of periodontal disease affecting some incisors. This is as a result of plaque accumulation on these teeth.

Figure 1.15 Enamel hypoplasia and dysplasia in a dog suffering from Distemper Virus infection. Note the unaffected persistent mandibular left deciduous canine.

odontoblasts and often results in abnormally shaped roots which undergo premature completion of apexogenesis (Figures 1.16–1.17).

Iatrogenic damage to the tooth before about four months of age can present as discolouration or enamel defects in the permanent dentition if care is

Figure 1.16 Radiograph of maxillary left canine (204) root in a dog suffering from Distemper Virus infection. Note the conical shape of the short roots. Premature completion of apexogenesis has occurred.

Figure 1.17 Radiograph of the rostral mandibles of a dog suffering from Distemper Virus infection. Note that the permanent canines are retained (unerupted) due to premature completion of apexogenesis. These teeth may need to be extracted. Note also the persistent mandibular right deciduous canine.

not exercised during the extraction of deciduous teeth (Figure 1.18). Fractured deciduous canines with exposed pulps leading to periapical pathology can also cause enamel defects on the developing permanent teeth (Figure 1.19).

Figure 1.18 Extreme care must be exercised when extracting persistent deciduous canine teeth, especially when this is performed for interceptive orthodontic purposes. Note the enamel defects on this tooth (404) due to iatrogenic damage during extraction of the mandibular right deciduous canine when this dog was ten weeks old. (Note the brachygnathic mandibles.)

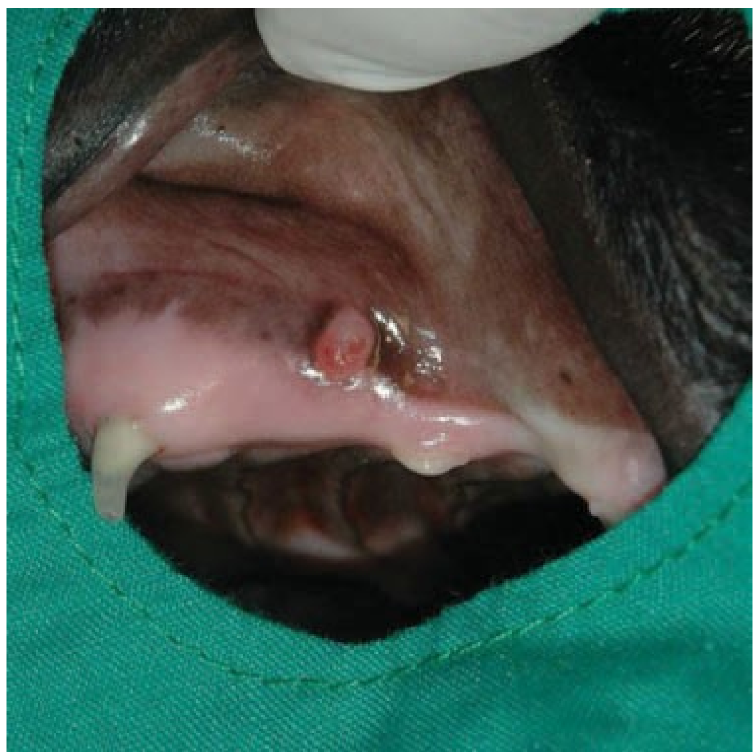


Figure 1.19 Fractured deciduous teeth must be treated or periapical pathology may result in damage to the adjacent developing permanent teeth.

Tooth type and shape

Dogs and cats have three incisors and one canine in each quadrant. The incisors are named: central, middle and lateral or numbered first, second and third.

Figure 1.20 The maxillary right deciduous canine is numbered 504 and the mandibular right deciduous canine 804 using the modified Triadan system.

Using the modified Triadan system the quadrants are numbered from 1–4, beginning with the right maxilla and ending with the right mandible in a clockwise direction as viewed from the front of the animal. Using this system, the maxillary right incisors are numbered 101, 102 and 103. Canines are suffixed by 4 (104, 204, 304 and 404) and first molars by 9 (109, 209, 309 and 409). The primary dentition is numbered in the same way, with the quadrant prefixes being 5, 6, 7 and 8 (e.g. maxillary right deciduous canine is 504 and mandibular right deciduous canine is 804 (Figure 1.20)). Figures 1.21 and 1.22 are radiographs showing mixed dentition in young dogs. Note the thin dentine walls and 'absence' of roots in the permanent dentitions.

In dogs with a full complement of permanent teeth the dental formula is:

$$2 \times \frac{\text{I3 C PM4 M2}}{\text{I3 C PM4 M3}} \quad \text{giving a total of 42 adult teeth.}$$

Dog deciduous dentition formula is:

$$2 \times \frac{\text{Id3 Cd PMd3}}{\text{Id3 Cd PMd3}} \quad \text{giving a total of 28 adult teeth.}$$

Figure 1.23 shows the mandibular right deciduous incisors 2 and 3, canine and premolars 2–4 in a young dog. Figure 1.24 shows the permanent mandibular right incisors 1 and 2 and the deciduous lateral incisor, canine and premolars 2 and 3 in a young dog. The dentition here is termed 'mixed dentition' as deciduous and permanent teeth are present.

In cats with a full complement of permanent teeth the dental formula is:

$$2 \times \frac{\text{I3 C PM3 M1}}{\text{I3 C PM2 M1}} \quad \text{giving a total of 30 adult teeth.}$$

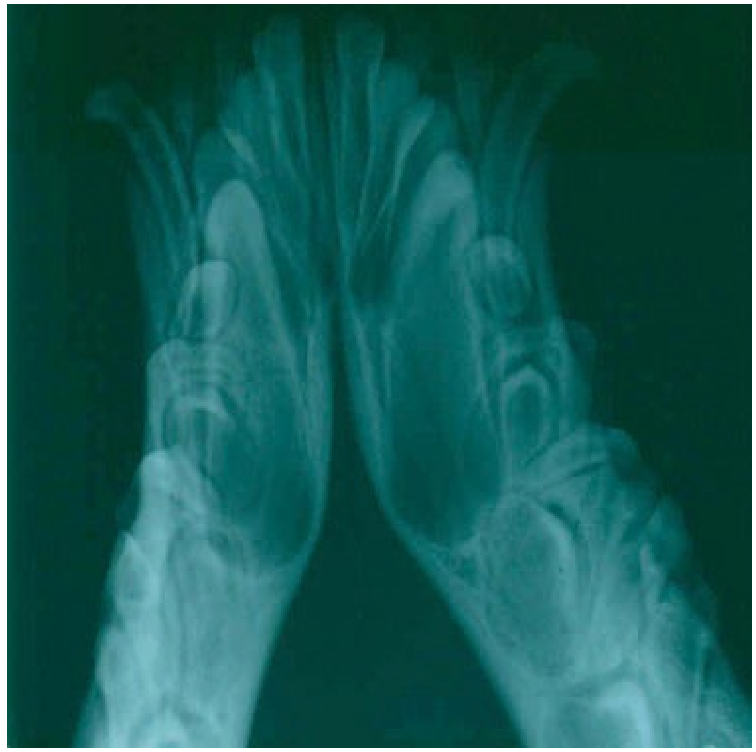


Figure 1.21 Radiograph of rostral mandibles of a young dog with developing permanent teeth.

Figure 1.22 Radiograph of rostral mandibles of a young dog that has linguo-verted mandibular deciduous canines. Note how crowded the permanent incisors are and how close the permanent canines are to each other.

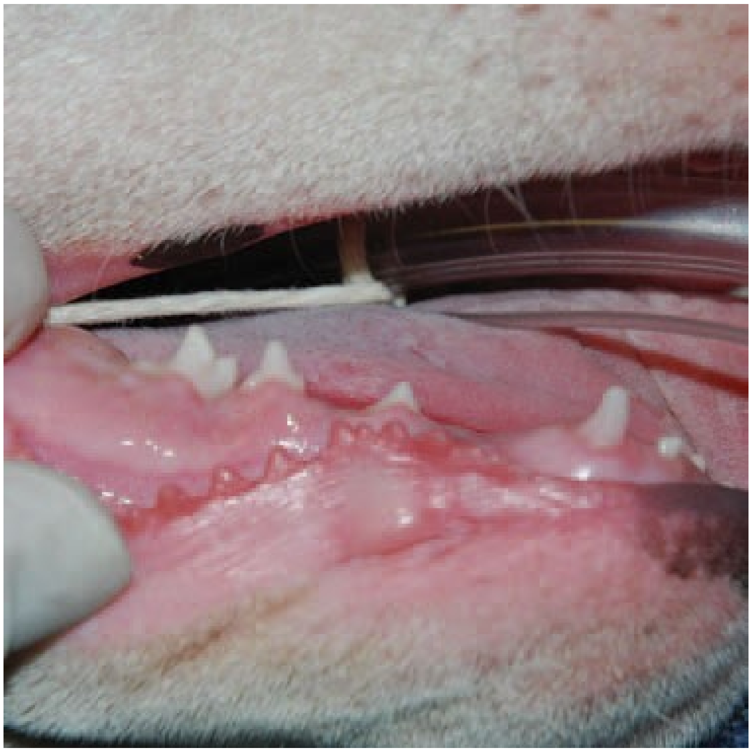


Figure 1.23 Deciduous dentition in the right mandible of a young dog. Middle and lateral incisors, canine and premolars 2–4 are visible.

Figure 1.24 Mixed dentition in a young dog. The permanent first and second incisors have erupted. The lateral deciduous incisor, canine and premolars 2 and 3 are still to be shed.

Figure 1.25 Deciduous dentition in a kitten.

Figure 1.26 Permanent dentition in an adult cat.

Cat deciduous formula is:

$$2 \times \frac{\text{Id3 Cd PMd3}}{\text{Id3 Cd PMd2}}$$ giving a total of 26 adult teeth.

Figure 1.25 shows the mandibular right deciduous teeth in a kitten. The incisors and canine are out of focus and premolars 3 and 4 clearly visible. Figure 1.26 shows the mandibular right permanent lateral incisor and canine and premolars 3 and 4 and molar 1 in an adult cat.

Cats are usually without the maxillary first premolar and second molar, the mandibular premolars 1 and 2, and molars 2 and 3.

In dogs, the incisors, canines, first premolars and mandibular third molars have one root each while the remaining mandibular premolars and molars

Figure 1.27 Mandibular right canine from a dog. Note the root comprises more than 50% of the tooth and that the greatest diameter is about halfway down the root.

Figure 1.28 Top: maxillary molars 1 and 2 have three roots each (one palatal and two buccal). Bottom: mandibular right canine and molar 1. Note the vestigial supernumerary root in the furcation of molar 1.

have two roots. Maxillary premolars 2 and 3 have two roots, whilst maxillary premolar 4 and the molars have three roots each (Figures 1.27 and 1.28).

Root configurations are similar in the cat except that the maxillary molar buccal roots may be fused.

Some two-rooted teeth may have a third root which can cause post-extraction abscessation if left behind – hence the need for pre-operative

Figure 1.29 The maxillary left third premolar has an additional cusp on the palatal aspect. Teeth that are shaped like this one often have a supernumerary root.

Figure 1.30 Radiograph of tooth in Figure 1.29. Note the supernumerary root. (Radiographic positioning to best visualise this root has resulted in superimposition of the distal and mesial roots on those of adjacent teeth.)

radiographs (Figures 1.29 and 1.30). In the cat, the maxillary second premolar (clinically the most rostral premolar) may have two roots in some animals. In some dogs, the two roots of the premolars or mandibular molar 2 may be fused. This is another reason for pre-operative radiographs, since sectioning these crowns may result in fracture and retention of a root fragment (Figure 1.31).

Figure 1.31 Fused roots in a dog mandibular premolar. Pre-operative radiography is necessary to prevent attempts at sectioning such teeth prior to extraction. These teeth can often be extracted using the simple extraction technique.

Figure 1.32 Supernumerary root fused to the distal root of maxillary left premolar 3 (207) in a cat.

Figure 1.32 shows a supernumerary distal root fused with the distal root of maxillary left premolar 3 in a cat. Figure 1.33 shows the tooth in Figure 1.32 after sectioning and extraction.

In the dog, the maxillary molars 1 and 2 and the mandibular molar 1 have a cutting and a grinding surface, while mandibular molars 2 and 3 have a single

Figure 1.33 The extracted tooth from the cat in Figure 1.32. Note that a wedge of crown was removed to improve access to the periodontal ligament space.

grinding surface, the latter teeth being bunodont (cheek teeth with a grinding surface). Except for the maxillary first molar, the cat does not have grinding surfaces on any of its cheek teeth. Teeth without grinding surfaces are termed secodont.

In the dog the premolar 1 and molar teeth do not have predecessors. In other words they are not true succedaneous teeth.

Permanent incisors erupt palatal / lingual to the deciduous incisors while the maxillary permanent canines erupt mesial (labial) to the deciduous canines and the mandibular permanent canines lingual to the deciduous canines. Permanent premolars erupt palatal / lingual to their predecessors. Persistent maxillary deciduous canines (Figure 1.34) and persistent mandibular deciduous canines (Figure 1.35) are commonly seen in dogs but appear to be rare in cats. (Figures 1.36 and 1.37).

Permanent teeth erupt as shown in Table 1.1.

Table 1.1 Age at which permanent tooth eruption occurs in dogs and cats.

Teeth (permanent dentition)	Approximate age at eruption	
	Dogs	Cats
Incisors	3–4 months	3–4 months
Canines	4–6 months	4–5 months
Premolars	4–6 months	4–6 months
Molars	5–7 months	4–5 months

Figure 1.34 Maxillary right persistent deciduous canine tooth (504) resulting in periodontitis caused by plaque and food trapping.

Figure 1.35 Mandibular right persistent deciduous canine tooth (804) in a dog.

Tooth anatomy and directional terms

The crown of the tooth is the part of the tooth visible in the mouth and covered by enamel. The crown joins the root at the tooth neck. The cemento-enamel junction (CEJ) separates the crown from the root which is covered by

Figure 1.36 Maxillary left persistent deciduous canine (604) and premolar 4 (608) in a young cat.

Figure 1.37 Maxillary right persistent deciduous canine (504) and premolar 4 (508) in a young cat (same cat as in Figure 1.36).

cementum (Figures 1.38 and 1.39). The crown is divided into occlusal, middle and gingival thirds, and buccal / labial and lingual / palatal aspects. The part of the tooth crown facing the dental arch midline is known as the mesial aspect of the tooth, while the part facing away from the midline is known as

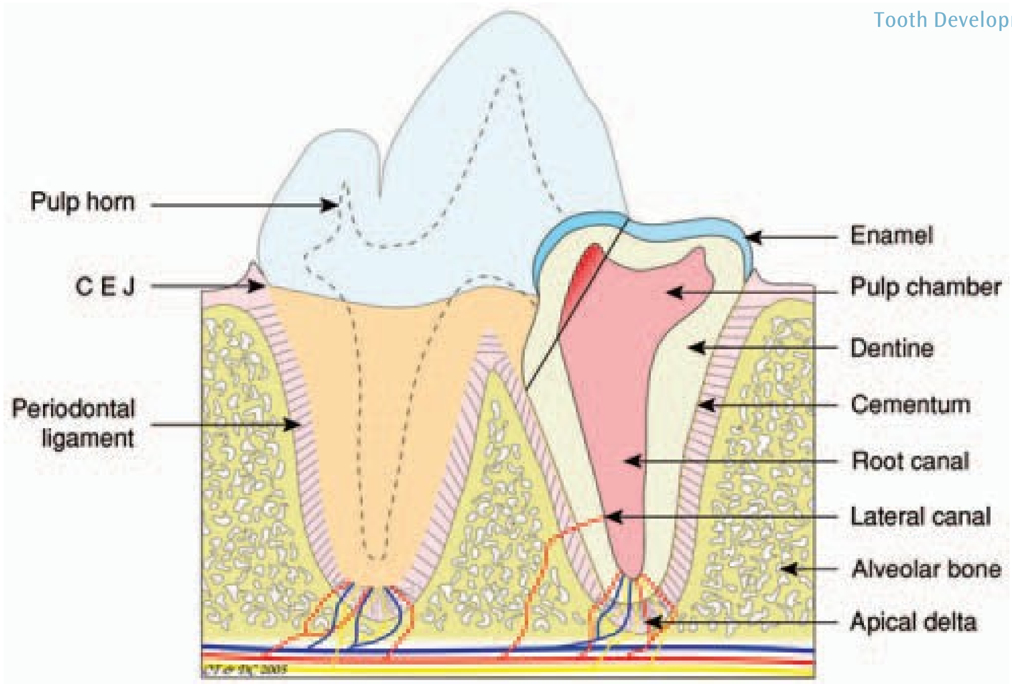


Figure 1.38 Schematic anatomy of a dog mandibular left permanent molar 1 tooth.

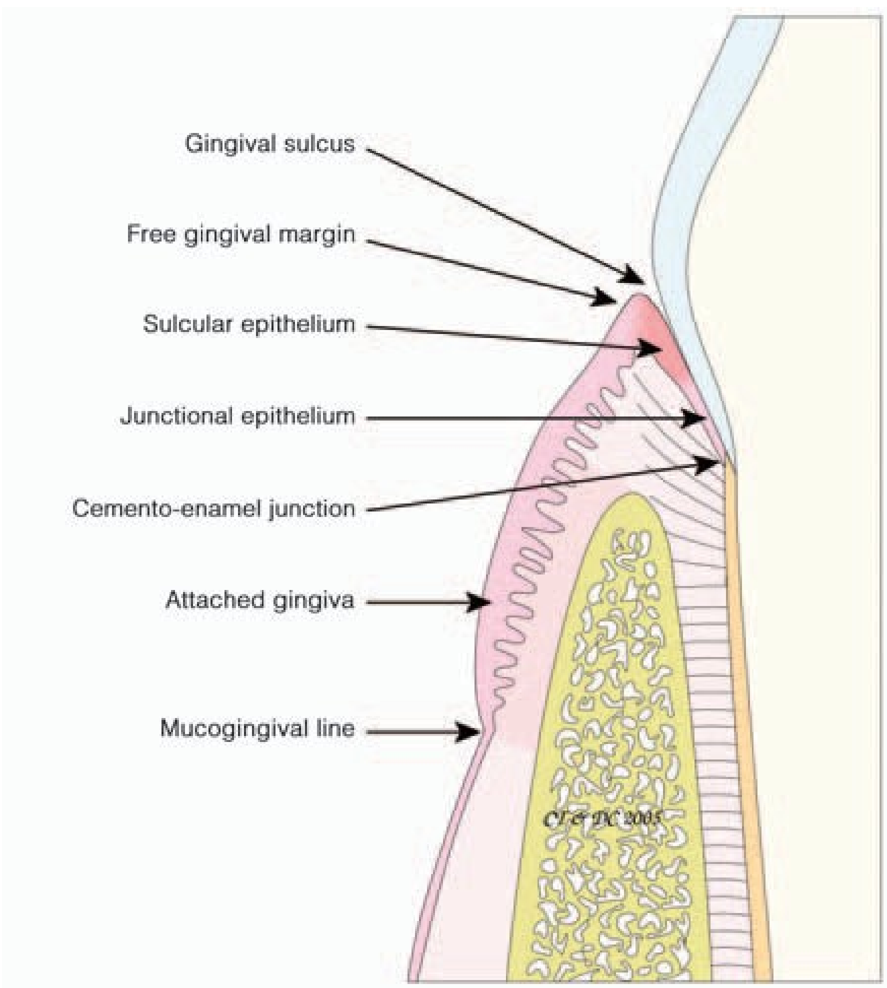


Figure 1.39 Schematic representation of relationship between tooth, soft tissues and alveolar bone.

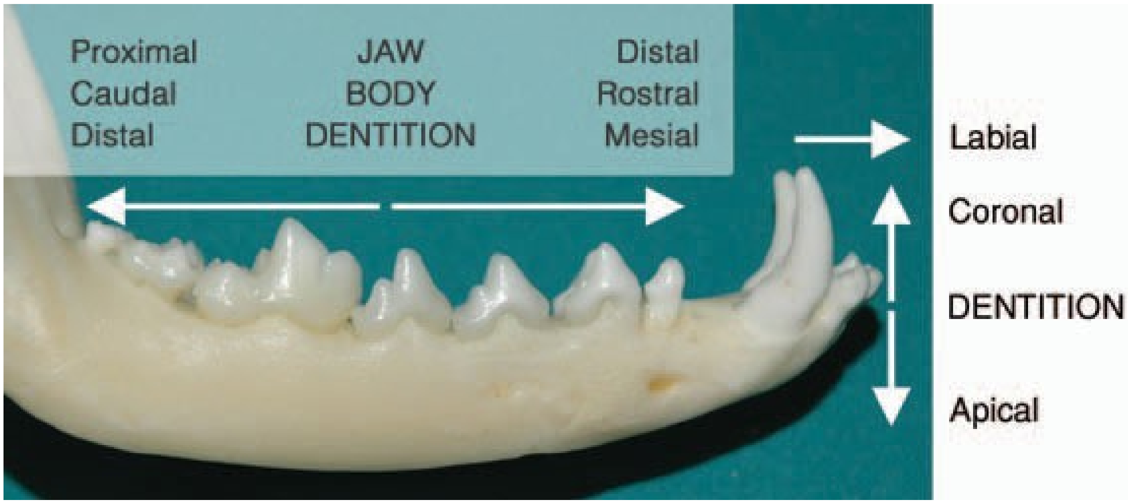


Figure 1.40 Directional anatomic terms for the mandible and its dentition (lateral view).

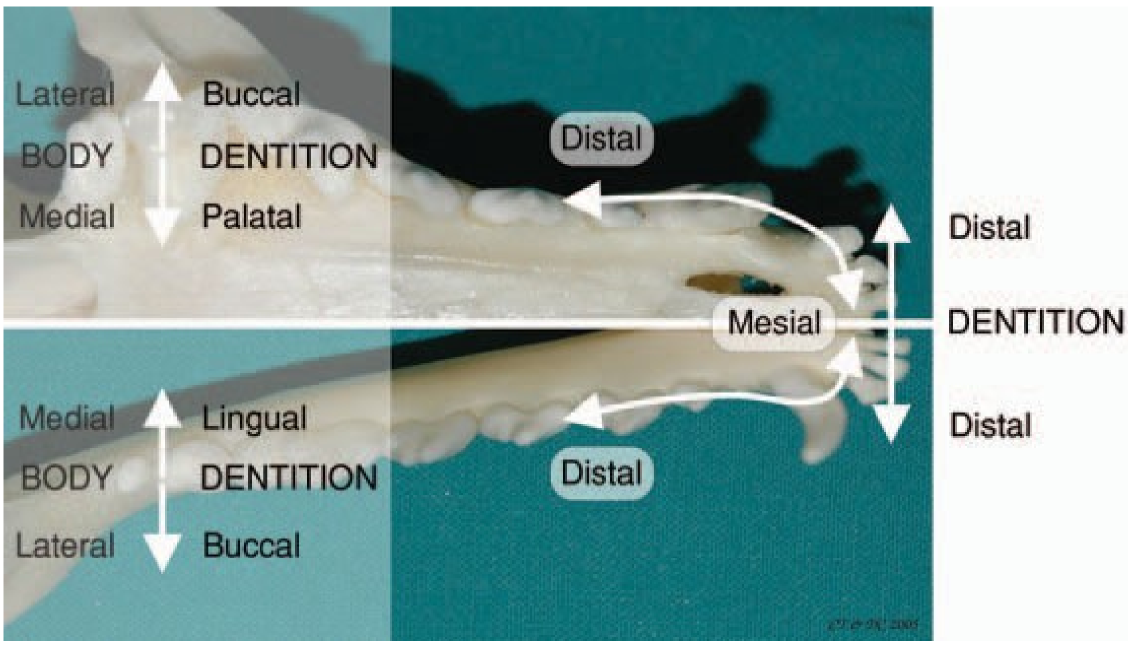


Figure 1.41 Directional anatomic terms for the mandible and maxilla and their dentition (occlusal view).

the distal aspect. Towards the tip of the root is termed apical and towards the tip of the crown is termed coronal / incisal. (Figures 1.40 and 1.41).

The 'front' of the mouth is termed rostral and the 'back' is caudal.

The tongue is made up of the root, body and tip and is attached to the floor of the mouth by the lingual frenulum.

The lower lip is attached to the attached gingiva, between the mandibular canine and second premolar, by the labial frenulum – a fibrous structure against which the palatal aspect of the maxillary canines occlude (Figures 1.42 and 1.43).

Figure 1.42 Right labial frenulum in a young puppy.

Figure 1.43 Right labial frenulum in an adult dog. Note that the palatal aspect on the maxillary right canine will come to rest against the frenulum when the mouth is closed.

The incisive papilla is situated just caudal / palatal to the maxillary central incisors and marks the opening of the incisivo-palatine ducts (Figure 1.44).

The puncta of the mandibular and monostomatic sublingual salivary glands are situated ventrally on either side of the lingual frenulum (Figure 1.45). The

Figure 1.44 The incisive papilla is situated palatal to the maxillary central incisors and should not be mistaken for a tumour.

Figure 1.45 The puncta of the mandibular and sub-lingual salivary glands are situated lateral to the lingual frenulum. In some animals these ducts join and secrete via one punctum.

puncta of the parotid and zygomatic salivary glands open almost adjacent to the maxillary carnassial (PM4) and molar 1 teeth in the buccal mucosa respectively (Figure 1.46). The buccal salivary gland puncta are visible in the buccal mucosa (Figure 1.47).

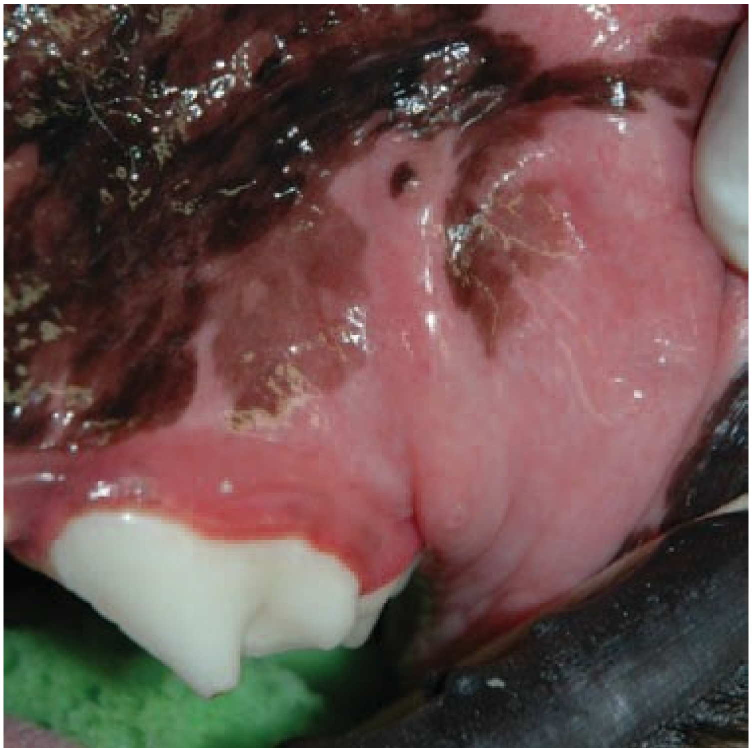


Figure 1.46 The parotid salivary duct punctum is partially pigmented in this dog and the zygomatic salivary duct punctum is visible near the first molar. Care must be exercised when creating surgical flaps in this area.

Figure 1.47 The puncta of the buccal salivary glands are visible in the buccal mucosa.

The thin groove dividing the upper lip is known as the philtrum (Figure 1.48).

The lower jaw comprises two mandibles that articulate at the fibrous symphysis rostrally.

Figure 1.48 The shallow groove separating the top lips is known as the philtrum.

Figure 1.49 The space between two teeth is known as a diastema. Here the diastemata between maxillary right lateral incisor and canine and canine and first premolar are visible.

The normal space between two teeth, for example between the maxillary lateral incisor and canine is known as a diastema (Figures 1.49 and 1.50).

The line separating the alveolar mucosa and attached gingiva is known as the mucogingival line (Figure 1.51). When a finger is placed on the attached

Figure 1.50 Diastema between mandibular left canine and first premolar.

Figure 1.51 The muco-gingival line demarcates the attached gingiva from the alveolar mucosa. It is usually furthest from the gingival margin, over the canine and carnassial teeth.

gingiva and moved from side to side it will glide over the gingival surface, whereas, when a finger placed on the alveolar mucosa is moved from side to side the alveolar mucosa moves with the finger. The attached gingiva is fixed tightly to the underlying periosteum (mucoperiosteum) whereas the alveolar

Figure 1.52 The fauces house the tonsils and are the areas medial to the glosso-palatine folds. The tonsils lie within their crypts and are often enclosed by a mucosal fold.

mucosa is not. In some animals a shallow line is seen to divide the free gingiva from the attached gingiva.

The palatine tonsils are housed in their crypts in the fauces and are usually partially covered by a mucosal fold (Figure 1.52).

Further reading

Bath-Balogh, M. and Fehrenbach, M.J. (1997) *Illustrated Dental Embryology, Histology and Anatomy*. W.B. Saunders Company, Philadelphia.

2 Clinical Examination

An accurate history should be obtained from the client. It bears mentioning that the client may not be the owner of the patient and some of the information supplied may be misleading. Leading and rhetorical questions should be avoided. If answers to particular questions do not fit the clinical picture they should be rephrased and repeated.

A routine clinical examination should be performed on all patients presented for dental procedures. This examination should include visual inspection and palpation of the animal and auscultation of the thorax to monitor heart and respiratory sounds. The colour of mucous membranes and the capillary refill time help provide an indication of peripheral circulation. Under certain circumstances body temperature should be taken and routine pre-anaesthetic blood test panels may be required. Depending upon the clinical and laboratory findings, the dental procedure may be postponed to allow further investigation of more serious signs than the presenting dental disease. Animals suffering with vomition and diarrhoea may have electrolyte imbalances which will affect decisions on general anaesthesia. Animals suffering from chronic conditions like cardiac insufficiency or systemic disease, such as diabetes, will require special attention.

It may only be possible to carry out a cursory examination of the mouth while the patient is conscious. This will depend on the demeanour of the patient. For reasons of health and safety, fractious animals should be sedated, tranquillised or anaesthetized to facilitate oral and dental examination. Most animals will tolerate having their lips raised to reveal their teeth, providing a glimpse of the occlusion and number of teeth present (Figure 2.1). Some animals will not allow open-mouth examination while conscious.

The head must be palpated to determine symmetry especially in dogs and cats which have a long hair coat. Pain may sometimes be elicited on palpation

Figure 2.1 The lips can be raised to obtain a cursory view of the teeth in most patients.

Figure 2.2 The oral cavity can be examined prior to ET tube placement.

of the head, face or eyes. Signs of heat and discharge (transudate or exudate) should be noted. Pain on manipulation of the jaws may be due to retro-bulbar pain caused by movement of the coronoid process.

The caudal oral cavity can be examined on placement of an endotracheal tube at induction of general anaesthesia. Having a light source shining over the examiner's shoulder will provide adequate illumination of the oro-pharynx, base of the tongue and fauces (area medial to glosso-palatine folds where the tonsils are situated) (Figure 2.2). By gently lifting the tongue out of the mouth it is sometimes possible to move the tonsils rostrally so that they can be seen more easily (Figure 2.3). The normal tonsil should be small, flattened laterally and positioned within its cleft. Periodically, foreign objects can be found projecting from the tonsillar cleft and may be associated with exudate.

At this stage the jaws can be manipulated to elicit any crepitus or abnormal motion of the temporomandibular joints. Lateral excursion of the jaws should also be evaluated (Figure 2.4 and Figure 2.5) to eliminate excessive lateral movement as a cause of inability to close the mouth (open-mouth locking).

The patient can then be intubated with an appropriately sized endotracheal (ET) tube which has been measured and shortened to reduce deadspace (if necessary) (Figure 2.6) and the cuff inflated adequately. The cuff should be inflated whilst pressure is exerted on the rebreathing bag. It is sufficiently inflated when there is no airflow past it. Over inflation of the cuff is severely detrimental to the patient and may cause tracheal rupture. In some cases the ET tube may fit so snugly that cuff inflation is unnecessary.

Light lubrication of the tube using a sterile lubricant will prevent adhesion of the tube to the respiratory epithelium lining the trachea. A pharyngeal pack should then be placed around the ET tube in the pharynx (Figure 2.7). Numerous materials can be used as a pharyngeal pack including cellulose

Figure 2.3 The tonsils are visible left and right just caudal to the glossopalatine folds. The left tonsil in this dog is enlarged and can be seen bulging from its crypt. A biopsy submitted for histopathology confirmed tonsillar squamous cell carcinoma.

Figure 2.4 Excessive right lateral excursion of the mandibles.

kitchen wipes (Figure 2.8), gauze swabs and commercially available pharyngeal packs. The pack should be moistened to conform to the pharyngeal opening. Note that the function of these packs is to prevent calculus, debris, toothpaste and blood from accumulating around the ET tube in the pharynx and trachea, thus preventing aspiration of these materials during extubation

Figure 2.5 Left lateral excursion of the mandibles. Canines are still in occlusion.

Figure 2.6 Trimming the ET tube to the correct length will reduce deadspace. The tip of the ET tube should be placed at the thoracic inlet and must not protrude beyond the incisors.

and recovery. The pack will not prevent fluid from accumulating around the tube.

When the patient has been stabilised under anaesthesia the oral examination can be undertaken.

Figure 2.7 A pharyngeal pack should be placed around the ET tube in the pharynx to prevent debris and blood clots from accumulating around the tube. Remember that the pharyngeal pack will not prevent passage of water.

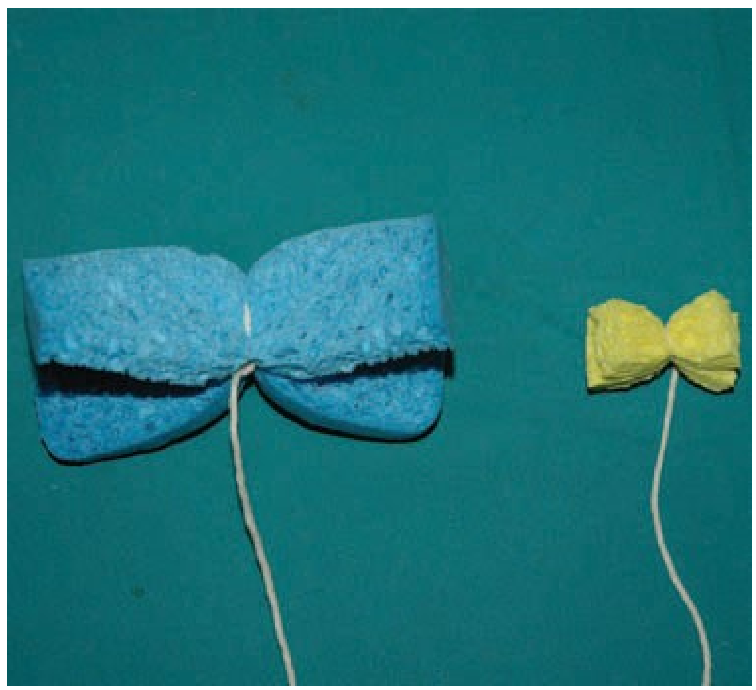
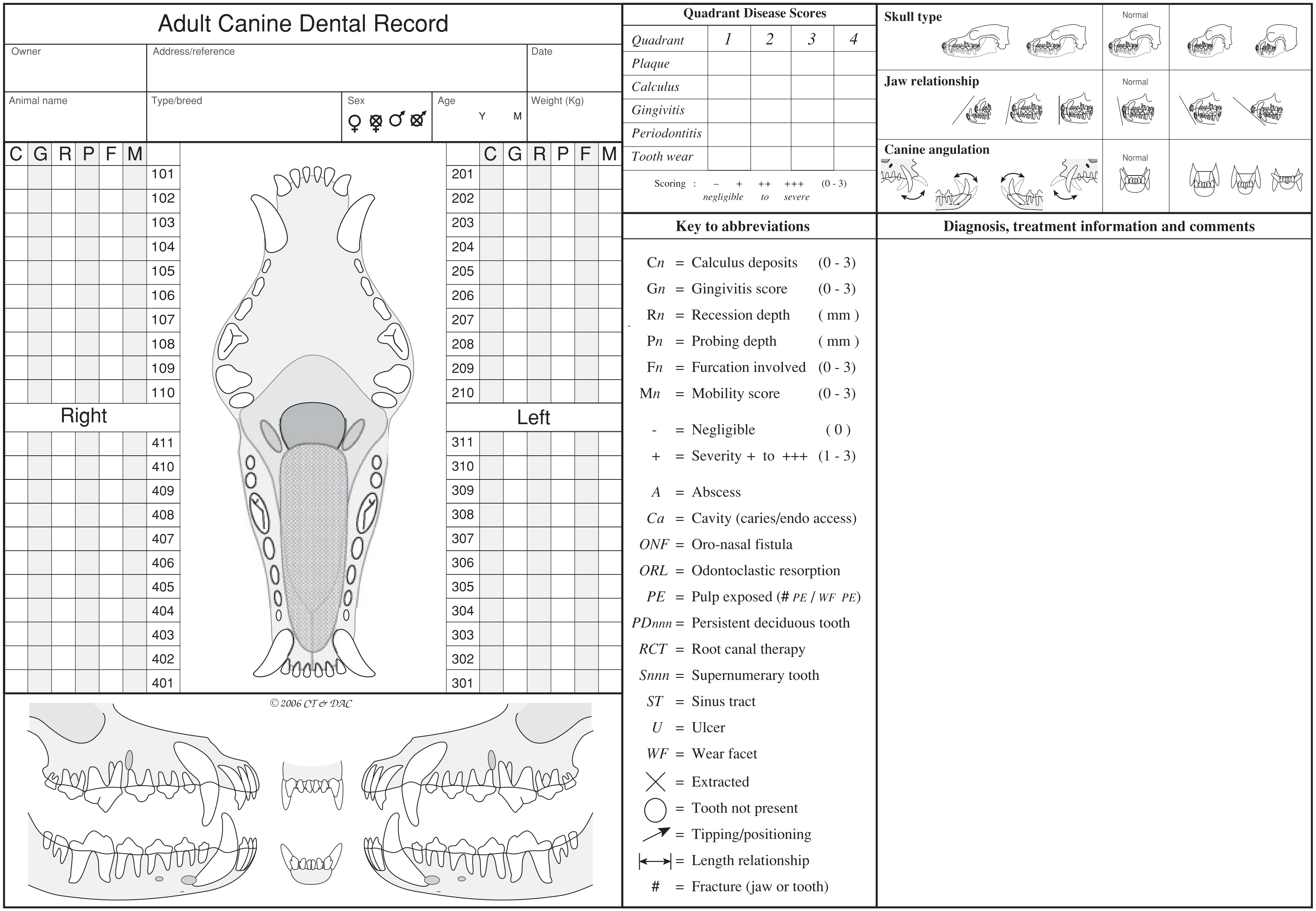


Figure 2.8 The pharyngeal packs in this photograph are cut from cellulose kitchen sponges.

The clinician should beware of ideolepsis and should develop a systematic approach to oral examination. An oral findings recording chart serves as an essential clinical record, aids in treatment planning a recording, and can be used for future reference for ongoing conditions (Figure 2.9a and b). A dental recording chart is essential for recording clinical findings, treatment planning and treatment recordings. They also provide a comparison from examination to examination.



Adult Canine Dental Record

Owner	Address/reference	Date
Animal name	Type/breed	Sex ♀ ⚲ ♂ ⚲ · Age Y M · Weight (Kg)

C	G	R	P	F	M	Right	Left	C	G	R	P	F	M
						101	201						
						102	202						
						103	203						
						104	204						
						105	205						
						106	206						
						107	207						
						108	208						
						109	209						
						110	210						
						411	311						
						410	310						
						409	309						
						408	308						
						407	307						
						406	306						
						405	305						
						404	304						
						403	303						
						402	302						
						401	301						

Quadrant Disease Scores

Quadrant	*1*	*2*	*3*	*4*
Plaque				
Calculus				
Gingivitis				
Periodontitis				
Tooth wear				

Scoring : – + ++ +++ (0 - 3) *negligible to severe*

Skull type Normal

Jaw relationship Normal

Canine angulation Normal

Key to abbreviations

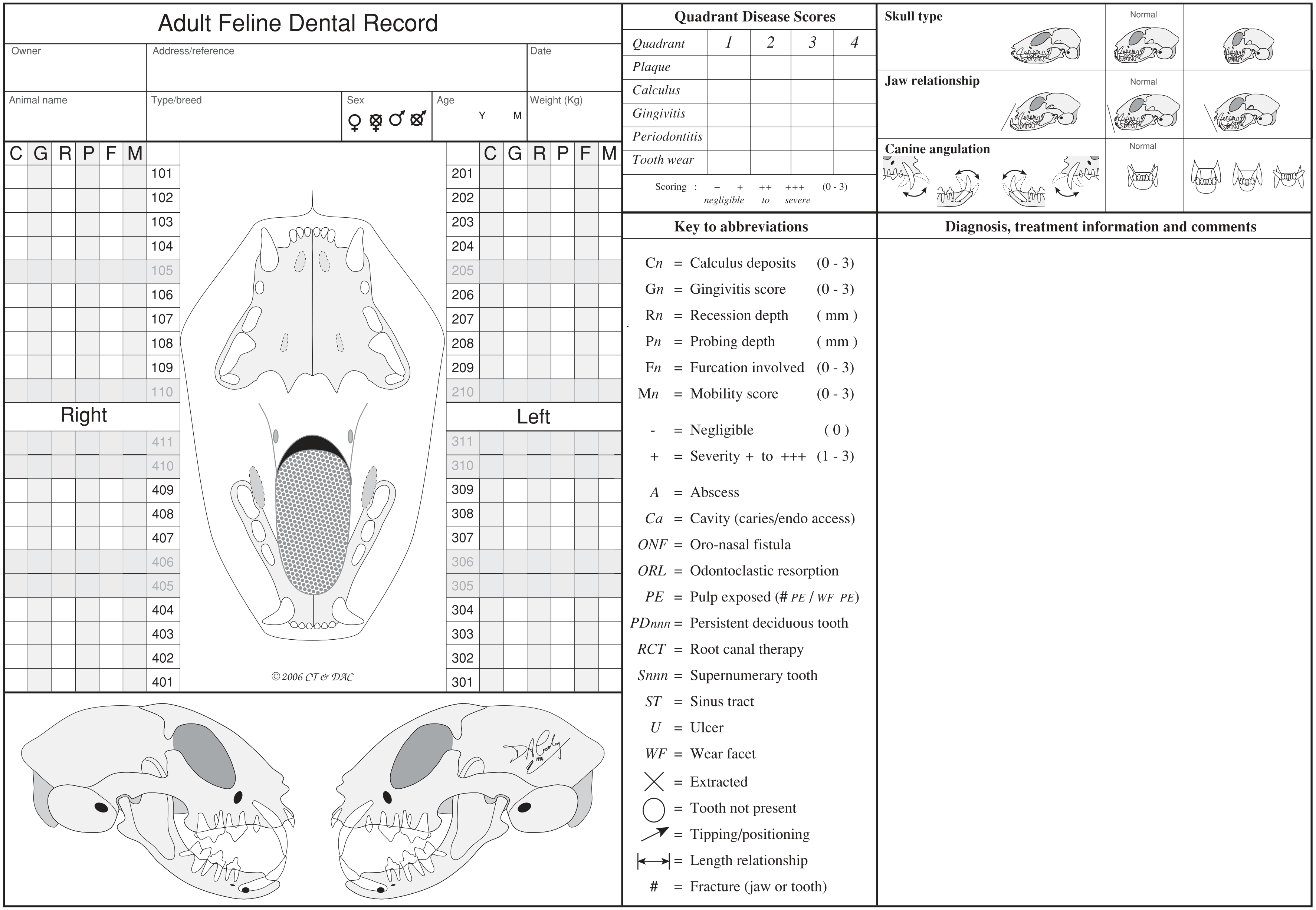
C*n* = Calculus deposits (0 - 3)
G*n* = Gingivitis score (0 - 3)
R*n* = Recession depth (mm)
P*n* = Probing depth (mm)
F*n* = Furcation involved (0 - 3)
M*n* = Mobility score (0 - 3)

\- = Negligible (0)
\+ = Severity + to +++ (1 - 3)

A = Abscess
Ca = Cavity (caries/endo access)
ONF = Oro-nasal fistula
ORL = Odontoclastic resorption
PE = Pulp exposed (# *PE* / *WF PE*)
PDnnn = Persistent deciduous tooth
RCT = Root canal therapy
Snnn = Supernumerary tooth
ST = Sinus tract
U = Ulcer
WF = Wear facet
X = Extracted
O = Tooth not present
↗ = Tipping/positioning
|←→| = Length relationship
\# = Fracture (jaw or tooth)

Diagnosis, treatment information and comments

Figure 2.9a An example of a canine recording chart.



Adult Feline Dental Record

Owner	Address/reference			Date
Animal name	Type/breed	Sex ♀ ⊗ ♂ ⊗	Age Y M	Weight (Kg)

C	G	R	P	F	M			C	G	R	P	F	M
						101	201						
						102	202						
						103	203						
						104	204						
						105	205						
						106	206						
						107	207						
						108	208						
						109	209						
						110	210						
Right							Left						
						411	311						
						410	310						
						409	309						
						408	308						
						407	307						
						406	306						
						405	305						
						404	304						
						403	303						
						402	302						
						401	301						

Quadrant Disease Scores

Quadrant	1	2	3	4
Plaque				
Calculus				
Gingivitis				
Periodontitis				
Tooth wear				

Scoring : – + ++ +++ (0 - 3)
negligible to severe

Skull type

Normal

Jaw relationship

Normal

Canine angulation

Normal

Key to abbreviations

Cn = Calculus deposits (0 - 3)
Gn = Gingivitis score (0 - 3)
Rn = Recession depth (mm)
Pn = Probing depth (mm)
Fn = Furcation involved (0 - 3)
Mn = Mobility score (0 - 3)

\- = Negligible (0)
\+ = Severity + to +++ (1 - 3)

A = Abscess
Ca = Cavity (caries/endo access)
ONF = Oro-nasal fistula
ORL = Odontoclastic resorption
PE = Pulp exposed (# *PE* / *WF PE*)
PDnnn = Persistent deciduous tooth
RCT = Root canal therapy
Snnn = Supernumerary tooth
ST = Sinus tract
U = Ulcer
WF = Wear facet
✕ = Extracted
○ = Tooth not present
↗ = Tipping/positioning
|↔| = Length relationship
\# = Fracture (jaw or tooth)

Diagnosis, treatment information and comments

Figure 2.9b An example of a feline recording chart.

Figure 2.10 Probing disto-buccally.

Each tooth should be examined individually along with its supportive structures. A periodontal probe (the dimensions of which are known – see Chapter 3) is used to probe the tooth sulcus circumferentially. The tip of the probe is introduced into the sulcus and slowly circumscribed around the tooth, measuring the depth of the sulcus (Figures 2.10–2.15). Most dental recording charts will make provision for recording of four to six periodontal depth measurements for each tooth. These should be at the vertical line angles, mid facial / buccal and mid lingual / palatal aspects. Sulcus depths measuring less than 3 mm in dogs and less than 1 mm in cats are considered normal (Figure 2.16). Once these depths are exceeded they are pathological pockets. Pseudopockets are formed by hyperplastic gingiva (commonly seen in Boxer dogs) (Figure 2.17). Gingival recession can also be measured using the periodontal probe (Figure 2.18). The handle of the probe can be used to determine tooth mobility by gently applying pressure to the tooth in a few places to determine movement.

Figure 2.11 Probing buccally.

Figure 2.12 Probing mesio-buccally.

Figure 2.13 Probing mesio-palatally.

Figure 2.14 Probing palatally.

Figure 2.15 Probing disto-palatally.

Figure 2.16 The periodontal probe is used to measure sulcus and pocket depths.

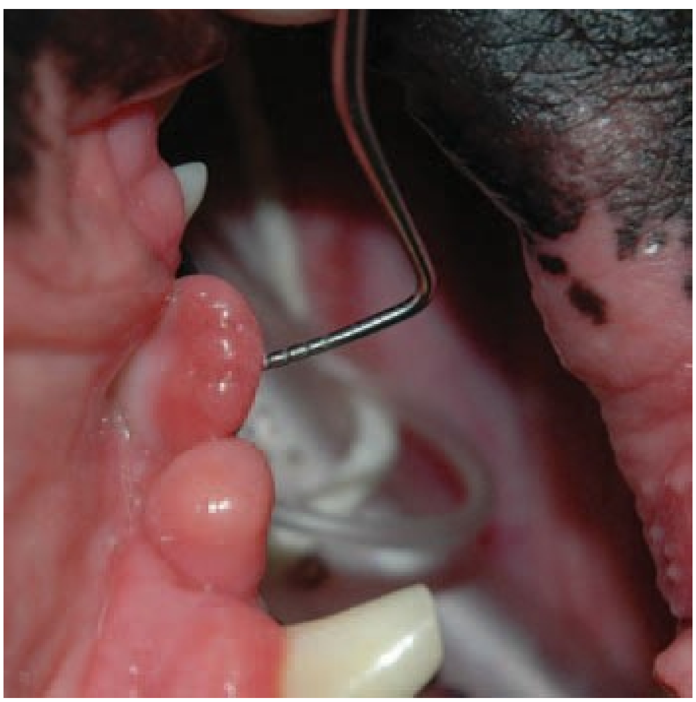


Figure 2.17 Pseudopockets formed by hyperplastic gingiva are measured using the periodontal probe.

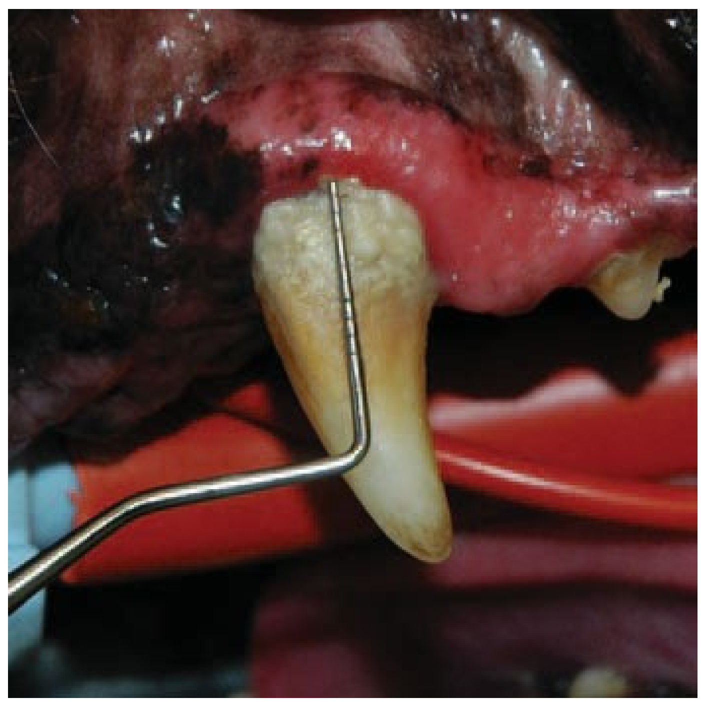


Figure 2.18 Gingival recession being measured using a periodontal probe.

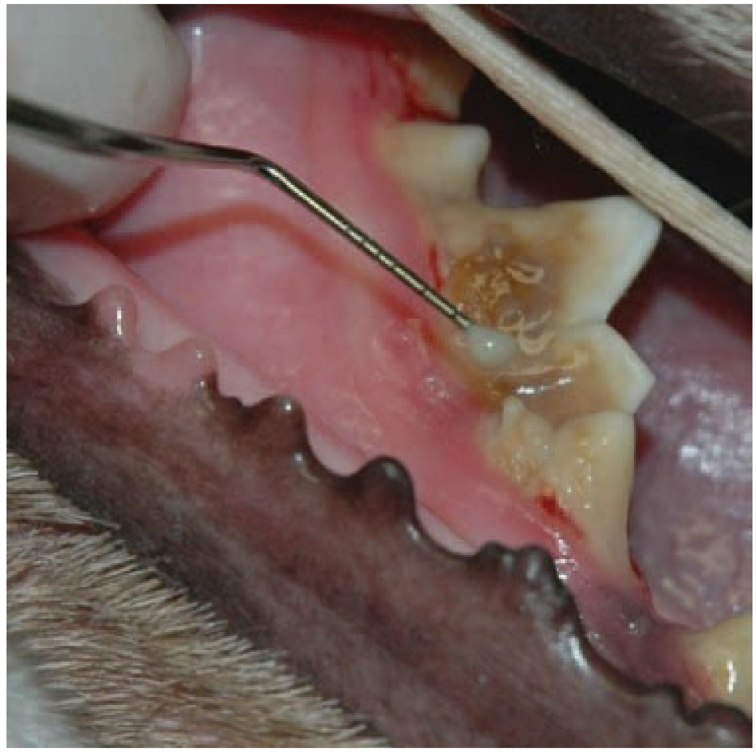


Figure 2.19 Presence of sub-gingival plaque can be determined by probing the sulcus / pocket using a periodontal probe.

Figure 2.20 This mandibular left molar has been scaled but not polished.

The periodontal probe can also be used to determine the thickness of plaque on the tooth surface and its presence in the gingival sulcus / periodontal pocket (Figure 2.19). Scant plaque is not visible to the naked eye, plaque-disclosing solution is required to reveal its presence (Figures 2.20–2.22).

Figure 2.21 Plaque-disclosing solution has been applied to the tooth in Figure 2.20.

Figure 2.22 The tooth in Figure 2.21 after polishing. The polishing procedure not only aims to recreate a smooth tooth surface but also removes plaque. Sub-gingival polishing is essential to remove sub-gingival plaque.

The gingivitis index is scored from 0–3, with 0 being healthy gingiva, 1 being slightly inflamed gingiva, characterised by swelling and marginal redness, 2 being moderate gingivitis characterised by bleeding on probing of the gingiva, and 3 being severe gingivitis characterised by spontaneous bleeding on being touched (Figures 2.23–2.26).

Figure 2.23 Healthy gingiva; no visible plaque or calculus.

Figure 2.24 Slight gingivitis (G1). Gingival margin is reddened. This dog has a supernumerary 205 (PM1).

Any enamel defects should be further examined using the dental explorer. This fine instrument improves tactile examination and will become snagged in enamel defects and create a tug effect when removed from a caries lesion which is explored.

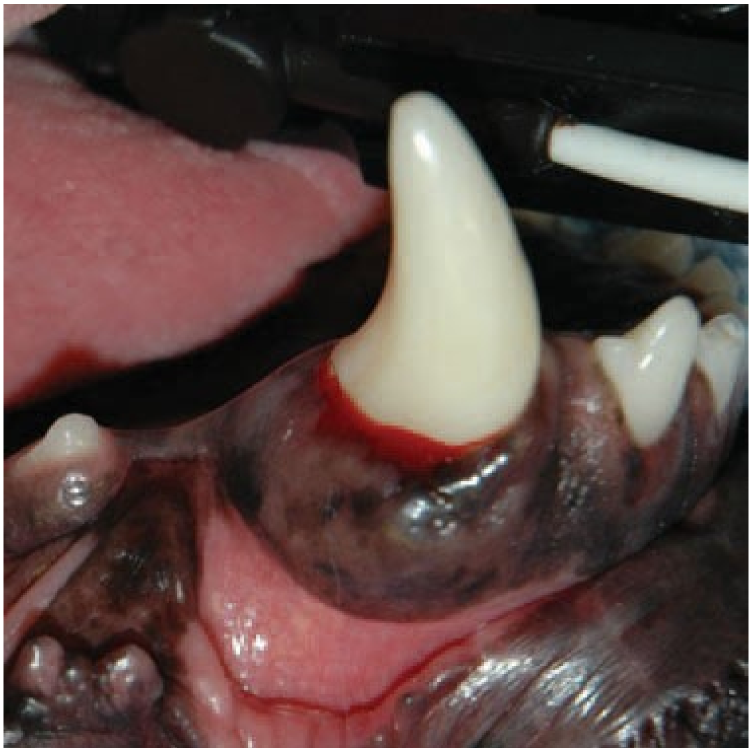


Figure 2.25 Moderate gingivitis (G2). Bleeding on probing.

Figure 2.26 Severe gingivitis (G3). Bleeding when lightly stimulated.

Calculus index is scored as slight where there is a small amount of calculus at the gingival margin, moderate where there is sub- and supra-gingival calculus and heavy where the majority of the tooth surface is covered by calculus (Figures 2.27–2.31). Although calculus itself does not cause gingivitis it has a

Figure 2.27 Healthy teeth and gums with no calculus on teeth.

Figure 2.28 Slight calculus and G1.

rough plaque retentive surface which exacerbates periodontal disease. See Table 2.1 for abbreviations used in recording clinical findings.

Once the clinical examination is completed the oral cavity should be rinsed with 0.12% chlorhexidine gluconate oral antiseptic (or similar product

Figure 2.29 Moderate calculus and G2 in a cat.

Figure 2.30 Heavy calculus in a dog. Majority of the tooth surface is covered by calculus.

known to be effective against plaque organisms) prior to the commencement of treatment (Figure 2.32).

If the animal is suffering from severe periodontal disease and the clinician, after probing the mandibular teeth, suspects that there is extensive bone loss it

Figure 2.31 Heavy calculus in a cat.

Figure 2.32 Oral antiseptic being applied in the mouth prior to commencement of the oral treatment. This significantly reduces aerosolized bacteria.

is advisable to take radiographs of the severely affected areas to determine whether the mandible is still intact or whether it has undergone a pathological fracture. These radiographs should be taken prior to the scale and polish procedure.

Description	Abbreviation or score
Calculus heavy	CH
Calculus moderate	CM
Calculus slight	CS
Gingival score – healthy	G0
Gingival score – marginal redness	G1
Gingival score – bleeds on probing	G2
Gingival score – spontaneous bleeding	G3
Mobility – slight	M1
Mobility – moderate	M2
Mobility – marked	M3
Furcation – indentation at furcation	F1
Furcation – probe passes into furcation but not through	F2
Furcation – probe passes from buccal to lingual / palatal	F3
Fracture	Fx or #
Pulp exposure	PE
Enamel defect	ED
Wear facet	WF
Oro–nasal fistula	ONF
Gingival recession	GR
Gingival hyperplasia / overgrowth	GH
Abrasion	AB
Attrition	AT
Secondary dentine	2D
Tertiary dentine	3D
Periodontal pocket depth	x mm
Feline odontoclastic resorptive lesions	FORL
Caries	Ca

Table 2.1 Commonly used abbreviations in dental charting.

Routine prophylaxis (scale and polish)

Moderate to heavy calculus can be removed using calculus-cracking forceps and / or electromechanical scalers (Figure 2.33). The use of calculus-cracking forceps is time saving but they must be used appropriately and carefully or severe damage can be caused to the tooth and gingiva. The forceps are applied to the calculus in such a way that shearing forces are created on the calculus in relation to the tooth surface (Figures 2.34–2.38). Under no circumstances should the tooth be pinched between the jaws of the forceps. In cats suffering from odontoclastic resorptive lesions the crown of an affected tooth may break off during an attempt to remove heavy calculus which may be covering the compromised crown. If resorptive lesions are noted on other teeth it is advisable to use other means of removing the calculus. Once the gross calculus has been removed using forceps, the remainder can be removed using manual (Figure 2.39), electromechanical (Figure 2.40) or pneumatic scalers.

Figure 2.33 Calculus-cracking forceps are available in numerous patterns.

Figure 2.34 Illustration of shearing force applied between tooth surface and calculus using calculus-cracking forceps.

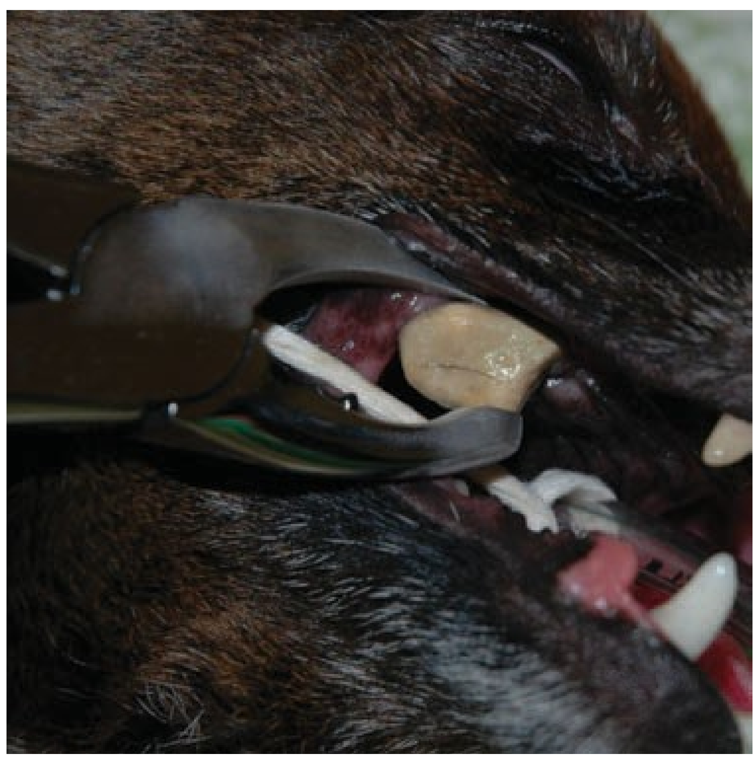


Figure 2.35 Applying calculus-cracking forceps to the tooth and calculus.

Figure 2.36 Shearing forces dislodge the calculus from the crown of the tooth.

Figure 2.37 Tenacious calculus may require multiple attempts to remove it.

Electromechanical scalers must be used with care. First, the tips of these scalers must never be applied perpendicular to the tooth surface as they will damage the enamel. Second, they must be properly adjusted with sufficient water flow both to keep the scaler tip and tooth from becoming heated and to

Figure 2.38 Removing tenacious calculus from the maxillary left carnassial in a cat. When the gingiva is severely inflamed bleeding often occurs during calculus removal using forceps or electromechanical scalers.

Figure 2.39 Hand curettes are efficient removers of supra- and sub-gingival calculus and diseased cementum during open-root debridement. (Root debridement is considered harmful by some as excessive cementum is often removed, denuding the dentine.)

flush calculus debris away. The scaler tip should not be kept within a deep pocket for protracted periods as this will lead to damage of the gingiva and possibly the pulp. (Numerous tips for sub-gingival scaling have been designed which deliver irrigant to the tip keeping it cool and flushing debris from within

Figure 2.40 Piezoelectrical scaler applied to the calculus. Do not spend more than about eight seconds on a tooth at one time or pulpitis may result.

Figure 2.41 A gentle, constant puff of air along the tooth crown will inflate the sulcus / pocket facilitating sub-gingival visualisation. (Forceful bursts of air are contra-indicated as they may cause emphysema and air emboli.)

the pocket. A gentle constant puff of air directed apically along the tooth crown using the three-way syringe will inflate the sulcus / pocket enabling sub-gingival visualisation (Figure 2.41). Gentle sub-gingival exploration using the dental explorer will also reveal residual calculus which must be differentiated

Figure 2.42 Plaque-disclosing solution should be applied after scaling and prior to polishing to improve polishing efficiency.

from resorptive lesions in both dogs and cats. When scaling teeth with tenacious calculus, move on to adjacent teeth and return to uncompleted teeth rather than spending long periods on a tooth at one time which would damage the tooth pulp.

Once the calculus has been removed a plaque-disclosing solution can be applied to the tooth surface to reveal the plaque, enabling the tooth to be polished more efficiently (Figure 2.42). When plaque-disclosing solution is not used, the extent of the plaque cannot be seen nor is it possible to see where the tooth has not been polished. Sufficient polishing paste must be used as this acts as a lubricant and gentle abrasive. The prophy cup or brush should be directed sub-gingivally to remove sub-gingival plaque (Figure 2.43). Once again, do not spend too much time on each tooth or frictional heat produced by the polishing device will cause thermal-induced pulpitis. Teeth are sometimes stained either intrinsically or extrinsically, tempting more aggressive scaling or polishing. Often stain will not come away and tooth damage must be prevented by limiting attempts to remove it (Figure 2.44).

When all teeth have been scaled and polished the debris and polishing paste should be flushed from the mouth using the three-way air–water syringe (Figure 2.45). Chlorhexidine gluconate oral rinse can be applied to the gingivae again prior to recovery especially if they are inflamed.

If further treatment is needed which requires the taking of radiographs, then they should be taken at this stage. Radiographing teeth which are covered in calculus will result in artefacts and should only be performed when pathological jaw fractures are suspected.

Figure 2.43 The rubber prophy cup should have sufficient pressure applied to it to cause it to deform and polish sub-gingivally.

Figure 2.44 Some teeth are stained so severely that thorough cleaning will not remove the staining. Repeated attempts at stain removal should be avoided to prevent tooth damage.

Figure 2.45 The three-way syringe is useful in flushing polishing paste and other debris from the mouth.

Further reading

Crossley, D.A. and Penman, S. (Eds) (1995) *Manual of Small Animal Dentistry*. BSAVA Publications, Cheltenham, UK.

Holstrom, S.E., Frost, P., and Eisner, E.R. (1998) *Veterinary Dental Techniques for the Small Animal Practitioner* (2nd edn). W.B. Saunders Company, Philadelphia.

Wiggs, R.B. and Lobprise, H.B. (1997) *Veterinary Dentistry Principles and Practice*. Lippincott–Raven, Philadelphia.

Small Animal Dentistry: A Manual of Techniques
Cedric Tutt

3 Equipping a Veterinary Dental Operatory

The 'Dental Room'

The veterinary dental operatory, commonly known in practice as the dental room, should not share air space with the preparatory area for aseptic procedures. Ideally, the room should be separate from the rest of the clinic, although this separation may be a single door (Figure 3.1). The dental area should have an air extraction system which will cause a negative pressure within the room. This ensures that aerosolised micro-organisms are discharged to the outside of the building in such a manner that they do not compromise public safety (Figure 3.2). It should not be possible for expelled air to re-enter the building via the fresh air supply. Expired anaesthetic gases can also be scavenged via the air extraction system (Figure 3.3).

The electromechanical dental scaling procedure causes aerosolisation of micro-organisms which will settle on work surfaces and walls, These surfaces

Figure 3.1 The dental operatory should comprise: a comfortable chair for the veterinarian and his assistant, a table on which to place the patient, an anaesthetic machine, dental radiography unit and chair-side developer, a light source, dental unit and an air extraction unit which will exhaust air to the outside.

Figure 3.2 An effective air extraction system should exhaust dental room air to the outside without compromising public safety.

Figure 3.3 Expired anaesthetic gases should also be scavenged from the anaesthetic system and expelled from the room. In this system anaesthetic gases are scavenged using the room air extraction system.

should therefore be impervious and easily cleaned. The tiling of walls could be a practical option.

Since radiography will be performed in the dental room as well, its location should take radiation safety precautions into consideration.

Health and safety considerations

The health of the veterinary surgeon, veterinary nurse and the patient are of utmost importance and necessary precautions should be taken to minimise exposure to hazards. The veterinary surgeon and nurse should wear protective spectacles to minimise ocular exposure to aerosolised micro-organisms and splatter, as well as debris generated by scalers and high-speed dental equipment. High-speed burs may fracture and these 'projectiles' can cause serious injury. Glass spectacles are not considered to provide ocular safety as they may shatter when impacted by a projectile. 'Half' spectacle lenses are also inappropriate for ocular protection. Appropriate surgical masks should also be worn to protect against inhalation of plaque micro-organisms. Theatre caps may be considered optional as the aerosolised plaque and splatter will settle on the operator's hair as well. Suitable protective attire should always be worn (Figures 3.4 and 3.5).

Once anaesthetised, the patient's eyes should be protected by an ocular lubricant and, depending upon the length of the procedure, this may need to be repeated. Covering the patient's face with a drape or small towel will also reduce the amount of aerosolised material settling on the patient's head. A towel placed under the patient's head will help drain fluid away

Placement of an inflated, cuffed endotracheal (ET) tube is essential to protect the lower airways from debris, blood clots and toothpaste. The ET

Figures 3.4 and 3.5 Appropriate masks and eye wear must be worn during dental procedures. Theatre head covering is optional but advised.

tube also keeps anaesthetic gases contained, reducing contamination of the work area and eliminates inhalation of aerosolised micro-organisms by the patient. A disposable pharyngeal pack will prevent blood and debris from accumulating in the pharynx.

Hand instruments

The periodontal probe is used to examine and evaluate gingival sulci (< 3 mm deep in dogs and < 1 mm in cats is normal) and periodontal pockets. The periodontal probe is a blunt-ended instrument which should have a rounded tip to prevent damage to the gingiva and graduations of known dimension (Figure 3.6). This enables the examiner to report the findings to the recorder accurately. A Williams 14 periodontal probe is commonly used in veterinary dentistry and can be read easily (Figure 3.7).

Dental explorers are sharp-tipped instruments of various shape used both to explore the visible tooth surface and to explore sub-gingivally to examine for calculus, after scaling is completed. The explorer will reveal sub-gingival odonto-clastic resorptive lesions which should be differentiated from sub-gingival

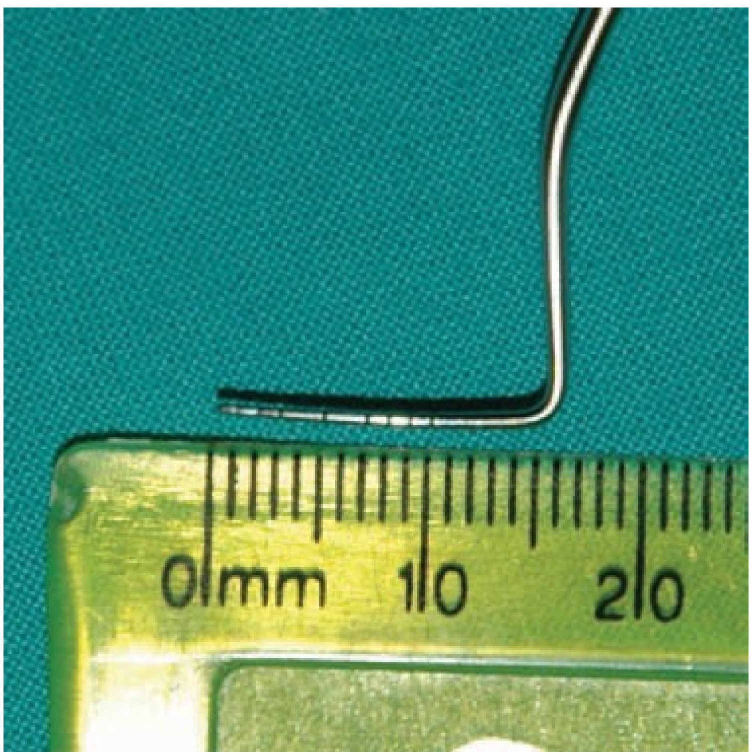


Figure 3.6 The graduations on the probe should be of known dimension for accurate recording of measurements.

Figure 3.7 A Williams 14 periodontal probe and dental explorer combination.

Figure 3.8 Three-way air-and-water syringe – a useful tool in veterinary dentistry.

calculus. Caries lesions tend to 'snag' the tip of the instrument, while it will slide over tertiary dentine protected lesions. The three-way syringe (Figure 3.8) is useful to flush the mouth, dry tooth surfaces and a *gentle* puff of air will distract the free gingiva from the tooth enabling visualisation of the gingival sulcus or pocket (Figure 3.9).

The dental mirror aids in visualisation of distal surfaces of caudal teeth and can be used to visualise lingual and palatal sub-gingival tooth surfaces. The

Figure 3.9 A gentle, constant puff of air can inflate the sulcus enabling sub-gingival visualisation.

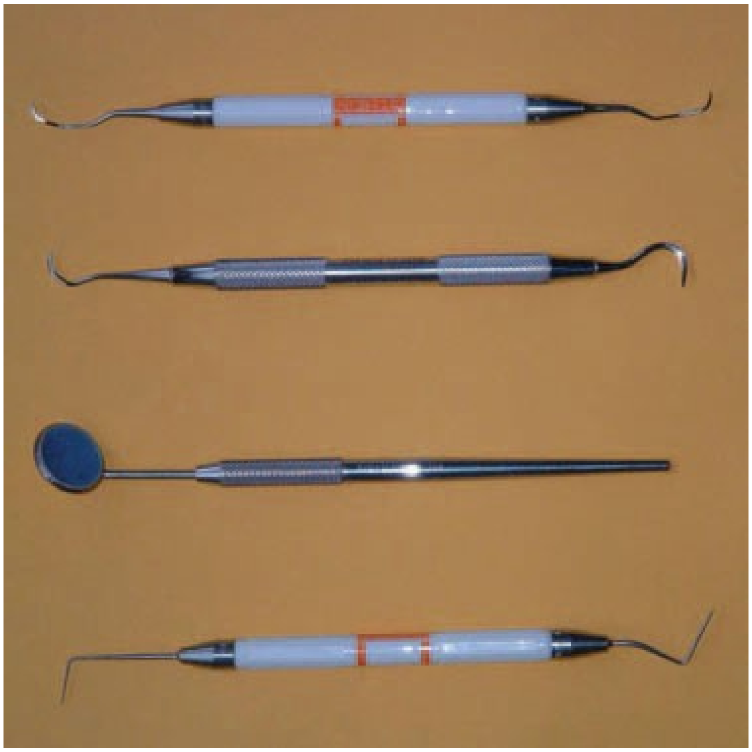


Figure 3.10 Periodontal examination and treatment kit comprising (from bottom): periodontal probe and explorer, dental mirror, dental scaler and curette.

dental mirror not only aids in visualisation of the distal aspects of teeth but also reflects light onto poorly lit oral tissues. It can also be used as an efficient cheek retractor. The mirror can also be used for visualisation of the naso-pharynx. Moistening the surface of the mirror using the three-way syringe or wiping the surface against the inside of the patient's cheek will prevent it from frosting (Figure 3.10).

There are many different patterns of hand instrument available for use in small animal dentistry (most having been designed for use in man). Hand scalers are used to remove calculus from the supra-gingival surface and curettes are used to remove sub-gingival calculus. Scalers should not be used sub-gingivally as they will traumatize the gingiva. A universal Hygienist scaler is adequate for veterinary dentistry. Curettes are used supra-gingivally and sub-gingivally (Figure 3.11). Universal or Gracey curettes are adequate for veterinary dentistry. Scalers and curettes must be used with care, to ensure that the tooth surface is cleaned but not damaged. Calculus within developmental grooves must also be removed with care. In some cases (e.g. the longitudinal developmental grooves on the canines of cats) the calculus may be left in place as to remove it will not only potentially damage the tooth but it is also impossible to polish these grooves with routinely used rubber prophy cups and they are thus left rough and plaque retentive.

Once all the calculus has been removed the tooth surfaces (supra- and sub-gingival) should be polished. Polishing not only attempts to recreate the smooth surface of the enamel but also removes plaque which is mostly not visible to the unaided eye. Plaque-disclosing solution may be applied to the teeth after scaling and before polishing to increase polishing efficiency. Prophy cups or brushes can be driven by electric or air motors. When the number of cases seen per week does not justify the purchase of a dental unit, an

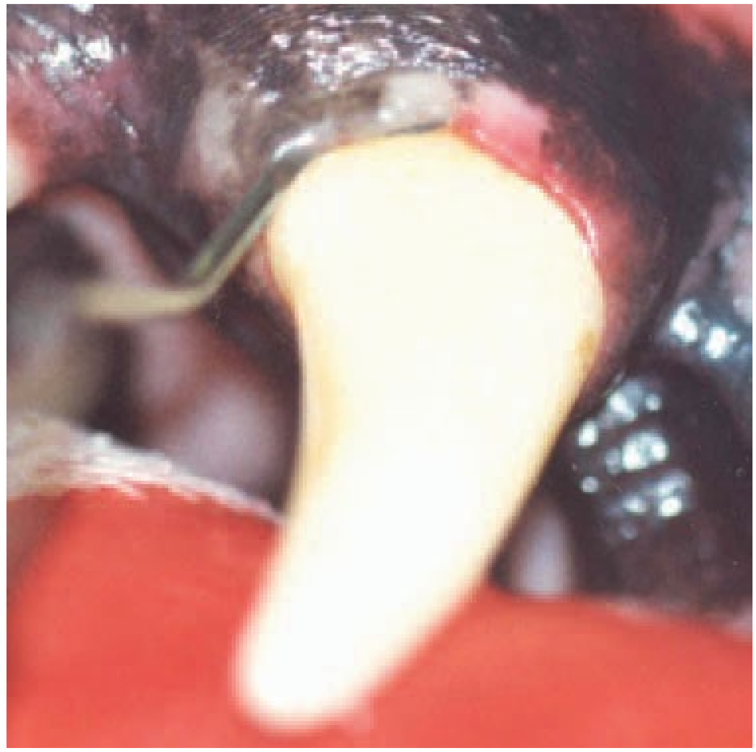


Figure 3.11 A curette being used to perform sub-gingival curettage.

electric-motor driven unit can be used effectively (micro-motor hobby drills) with a latch-key prophy cup used to polish teeth). Hand polishing using a tooth brush (manual or electric) is not beneficial but is suitable for dental homecare to be performed by the pet owner.

Power scalers

Ultrasonic

Electromechanical scalers are divided into two categories: magnetostrictive and piezoelectrical. In the former group, an electric current applied around a ferrite rod or a 'metal stack' causes the attached tip to oscillate, whereas in the latter group an electric current applied to a crystal results in deformation of the crystal and oscillation of the scaler tip in the hand piece. Some magnetostrictive scalers have a smaller amplitude of oscillation which allows more efficient coverage of the tooth surface. Magnetostrictive scalers have a flat orbital oscillation pattern, while piezoelectric scalers have a linear oscillation pattern. Magnetostrictive scalers create cavitation circumferentially around the scaler tip, piezoelectric scalers only create cavitation at each end of the linear oscillation. Cavitation is the formation of small air bubbles within the coolant which implode on the tooth surface, assisting in removal of calculus. It has also been shown to damage the cell membrane of spirochaetes commonly found in plaque. Some magnetostrictive and piezoelectric scalers have tips which can be used sub-gingivally as coolant is delivered to the apex of the scaler, preventing thermal damage to the tooth or gingiva. The frequency of these scalers is typically in the range of 16 000–32 000 Hz (Figures 3.12 and 3.13).

Figure 3.12 The water flow must be correctly adjusted to aid in cooling this instrument and also flush away debris.

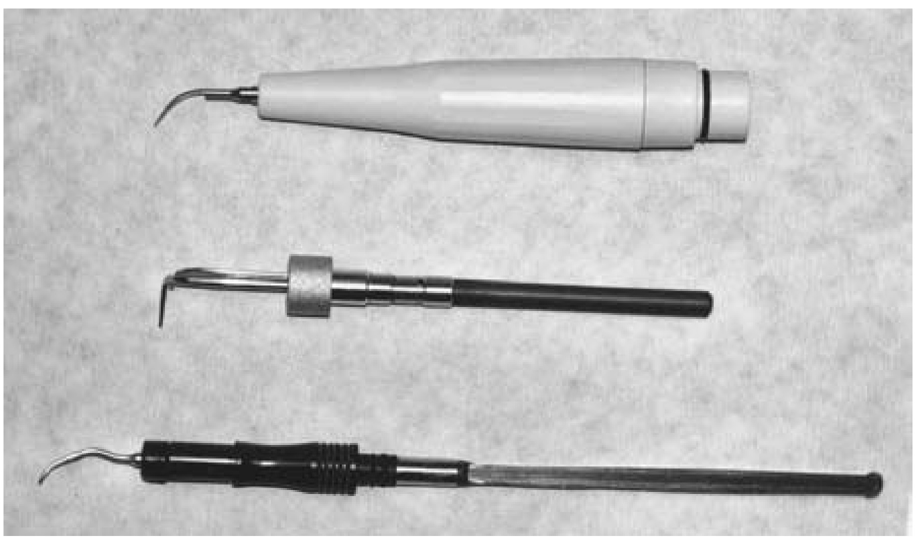


Figure 3.13 Ultrasonic scalers. From bottom: Magnetostrictive metal stack and ferrite rod and piezoelectric handpieces.

Sonic

Sonic scalers are pneumatic and the oscillation of their tips is caused by air driven through an eccentric hole in a rod within the hand piece. These scalers also have tips which can be used sub-gingivally (Figure 3.14).

Polishers

Electric (Figure 3.15) or pneumatic motors (Figure 3.16) may be used to drive prophy cups or brushes. Care should be exercised when selecting prophy

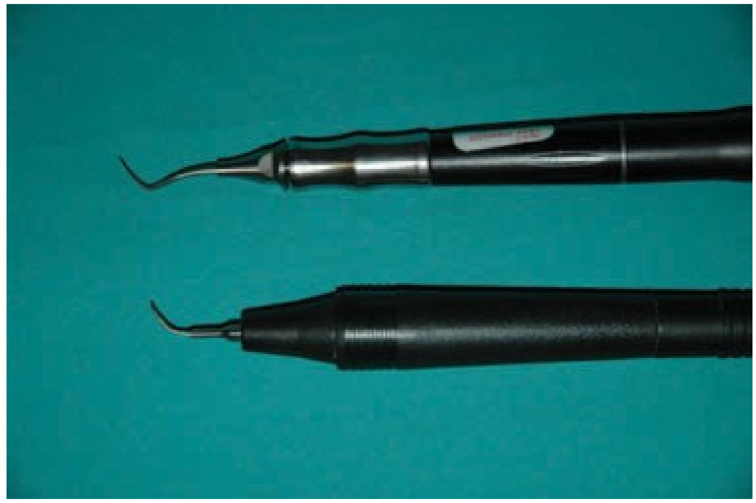


Figure 3.14 Sonic (upper) and piezoelectric (lower) scalers. This sonic scaler is air driven.

Figure 3.15 An electric motor-driven polisher. These instruments have higher torque than air-driven motors. Speed and direction control buttons are situated on the control box.

Figure 3.16 An air-driven motor. Direction of rotation can be reversed by turning the speed and direction collar at the base of the hand piece.

brushes (Figure 3.17). Nylon-bristled brushes can remove cementum from exposed root surfaces and should therefore not be used sub-gingivally. Natural bristle should be used in preference.

When using prophy cups sufficient pressure should be applied to the cup to cause it to deform and slide sub-gingivally (Figure 3.18). Sub-gingival polishing is essential to remove plaque. Rotating prophy polishers must be set at less than 3500 revolutions per minute. If the prophy head persists in unscrewing from the hand piece rotate the direction and speed adjustment ring at the base of the hand piece to the other side. This will change the direction of rotation and keep the prophy head in place (Figure 3.19). Some prophy heads oscillate rather than rotate.

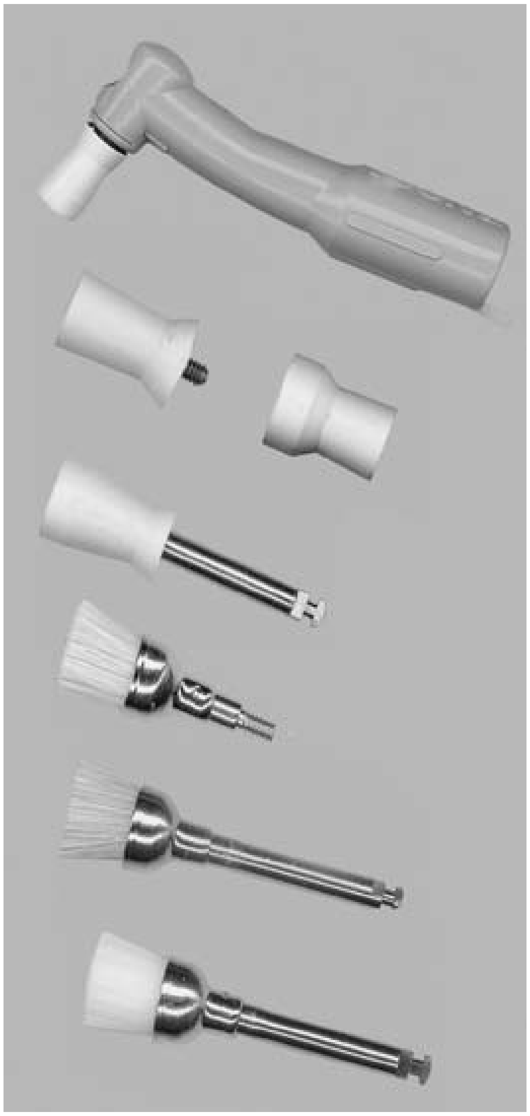


Figure 3.17 Numerous polishing devices are available. Natural bristle brushes are preferable to nylon bristles as the latter can strip cementum from the root surface.

Figure 3.18 The polishing cup should be applied to the tooth surface with sufficient pressure to deform it and allow sub-gingival polishing.

Figure 3.19 The ring at the base of the air motor adjusts drive direction as well as speed. Incorrect position will result in 'screw-on' prophy cups repeatedly unscrewing.

Figure 3.20 Prophy paste is available in multi-dose or individual patient tubs. Use of the latter eliminates the possibility of cross-contamination.

Polishing paste

Dental prophylaxis paste is available in numerous flavours, consistencies and textures. A medium abrasive texture is usually used in animals. High abrasive paste will damage the enamel surface making it more plaque retentive and should therefore not be used. Although dental prophy paste is available in multi-dose tubs, single patient pots are preferable in order to prevent cross-contamination (Figure 3.20). Single aliquots can be decanted from a multi-dose pot and placed in an appropriate receptacle. Under no circumstances should the paste be scooped from a multi-dose pot using the prophy cup during the polishing procedure!

Three-way syringe

The three-way syringe is a very useful piece of equipment when performing routine dental prophylaxis. The air-and-water syringe is used to flush calculus and other debris, as well as tooth paste, from the patient's mouth. A *gentle* puff of air directed toward the free gingiva along the crown of the tooth will

inflate the gingival sulcus (or pocket), facilitating direct visualisation of the sub-gingival surface, ensuring that all calculus is removed. A *gentle* puff of air over the crown of the tooth will dry the surface and expose residual calculus that will resemble a chalk-like substance on the crown which may not be visible when the tooth surface is wet.

Slow-speed air motor

The slow-speed air motor drives the prophy attachment (snap-on, screw-in or latch key contra-angles or right-angle disposable prophy head), latch-key burs and straight burs for trimming rabbit and other small herbivore teeth. Slow-speed motors fitted with speed-increasing hand pieces with a built-in water supply can be used for teeth sectioning. Contra-angled hand pieces may be fitted with latch key or push button bur chucks (clutches). The speed and direction of rotation is adjusted by rotating a collar at the base of the air motor (see Figure 3.19 above). The speed should be adjusted to not more than about 3500 rpm for polishing purposes. Too high a polishing speed will result in thermal injury to the tooth.

High-speed (turbine) hand piece

Most high-speed hand pieces make use of a push-button friction grip or screw-type chuck for securing burs.

In veterinary dentistry the high-speed hand piece is mainly used for sectioning teeth, alveolotomy prior to extraction and alveoloplasty in anticipation of flap closure. However, it is preferable to perform alveolotomy and alveoloplasty using a slow, surgical hand piece to prevent air embolisation and emphysema. The turbine rotates at 300 000–450 000 rpm and is a high speed, low torque instrument. Most efficient function is attained when the bur is rotating at full speed (pedal fully depressed) and a light brush stroke is used. As soon as too heavy a load is applied the cutting efficiency drops off (accompanied by an audible drop in pitch of the sound generated by the turbine) and the turbine may stall. Heavy loading will also shorten the life of the bur which will soon become blunt and may damage the bearings within the turbine head. Adequate coolant (water, polyionic fluid or in some cases, depending upon manufacturer's recommendations, antiseptic) is essential to keep the bur and tooth cool and flush debris from the operating site, keeping the bur from becoming clogged. Antiseptic solutions should not be used as flushing agents when performing alveolotomy and alveoloplasty as they are detrimental to cells and may delay wound healing. The high-speed hand piece is held using the modified pen grip with the fourth finger used as a rest on adjacent structures (Figure 3.21).

Dental burs

Dental bur types are almost innumerable. In general veterinary dental practice, round, pear-shaped and fissure (flat (cylindrical) or tapered) burs will be required. A couple of sizes in each of these shapes will suffice and can be ordered from your local dental supplier. Ideally, a bur should be used on one patient only and then discarded. When numerous teeth are to be sectioned, more than one bur may be required to complete the task. Dental burs are made of tungsten carbide or stainless steel and may be covered in diamond

Figure 3.21 The high-speed hand piece is held using the modified pen grip, with the fourth finger used as a rest on adjacent structures.

fragments. A small brass-wire brush should be used to remove debris from the burs which may be sterilised in an autoclave or using a disinfectant (cold sterilisation). A nylon nail brush can be used to clear tooth and bone debris from diamond burs, which are usually reused. It is important to ensure that the coolant flow is adjusted appropriately to ensure that the tooth and bone are not damaged by frictional heat. Dental burs should be stored in a bur stand (Figure 3.22).

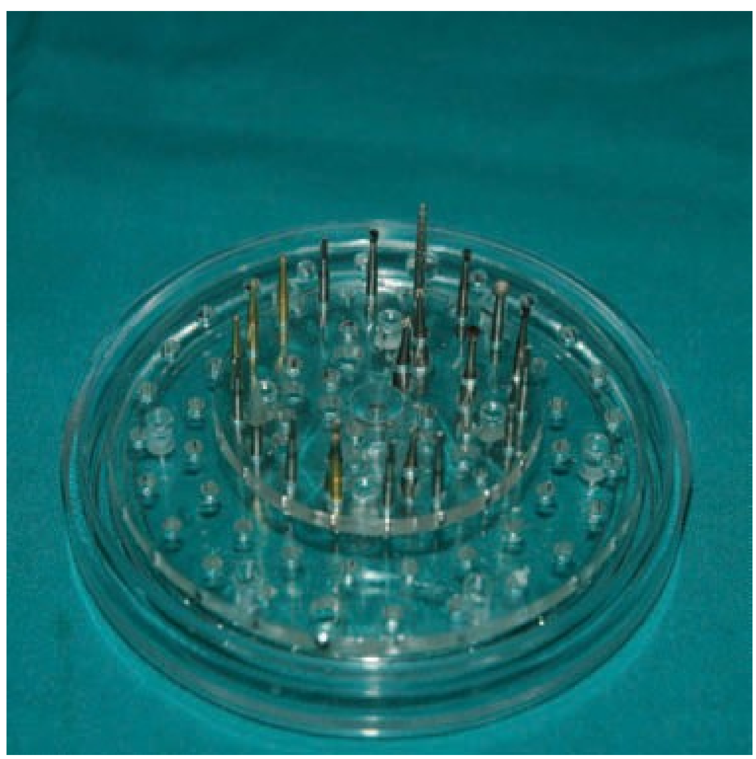


Figure 3.22 Dental burs should be stored in a bur stand.

Dental luxation and elevation

Luxator® (Figure 3.23) is a range of fine dental instruments used to sever the periodontal ligament and create space for the more robust dental elevators (Figure 3.24). The instrument is held in the palm grip with the forefinger extended along the shank to aid stability and prevent injury should the

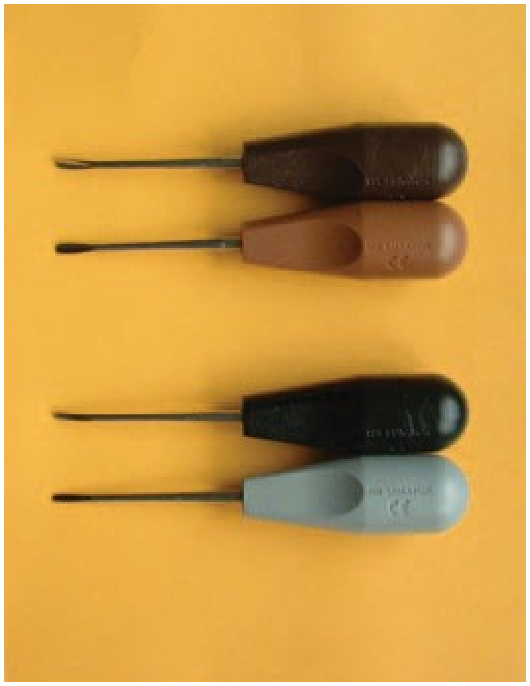
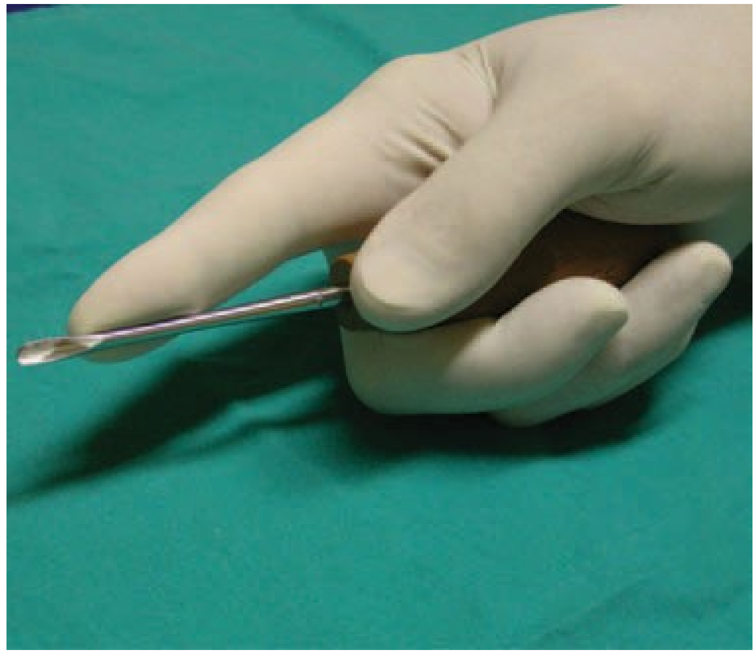


Figure 3.23 Dental luxators are fine, sharp instruments used to sever the periodontal ligament and compress alveolar bone, creating space for insertion of dental elevators.

Figure 3.24 Dental elevators are more robust than luxators and are used to apply rotational leverage forces to the tooth root, further compress alveolar bone and deliver the tooth.



Figures 3.25 and 3.26 Dental luxators and elevators are held in the palm grip, with the index finger extended along the shaft of the instrument, minimising injury should they slip off alveolar bone or tooth substance.

Luxator®slip off the tooth or bone (Figures 3.25 and 3.26). The instrument is advanced between the tooth and the alveolar bone in an apical direction and rotated clockwise and anti-clockwise alternately. When reaching the end of each rotation, gentle rotational pressure is to be applied and held for ten to thirty seconds. Once sufficient space has been created between the tooth and alveolar bone an elevator may be used to further loosen the tooth. Elevators are more robust than luxation instruments and are used to elevate the tooth from the alveolar socket/s. Under no circumstances should the luxation or elevation instruments be used in a manner resembling the opening of a paint pot using a screw driver! (Figure 3.27).

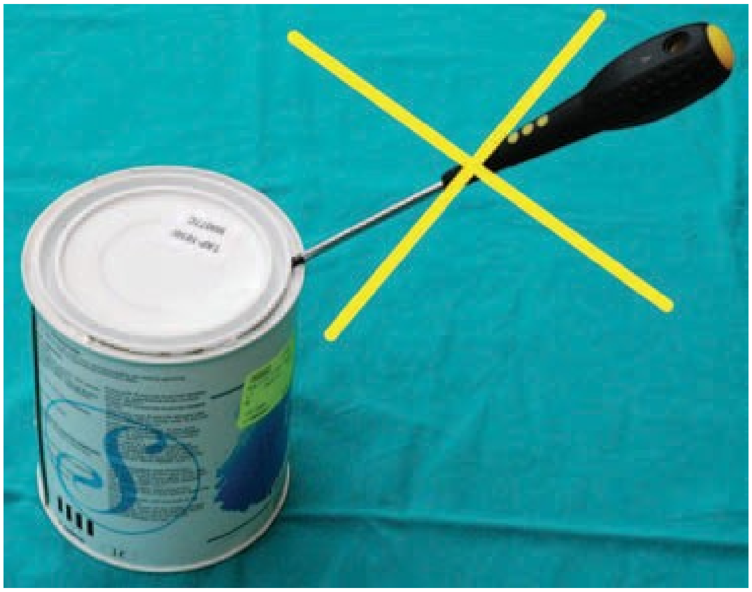


Figure 3.27 Neither luxators nor elevators should be used in the manner in which a paint can is opened using a screw driver. This type of manoeuvre will break these instruments.

Dental prophylaxis

Routine dental prophylaxis includes removal of plaque and calculus followed by polishing of the supra- and sub-gingival teeth surfaces. Once the animal's mouth has been examined and charted, the teeth and oral cavity should be flushed using an oral antiseptic solution. The teeth are then scaled and polished prior to other treatments being performed except in patients with severe periodontal disease where the taking of radiographs is indicated before the scale and polish procedure to prevent iatrogenic jaw fractures. Gross calculus can be removed from the tooth surface using calculus-removing (cracking) forceps (Figure 3.28). Care should be exercised when using these instruments not to damage the tooth or gingiva. One jaw of the forceps is positioned on the incisal edge of the tooth while the other is placed on the gingival extent of the calculus. The resulting shearing force applied to the calculus and tooth when the forceps are closed dislodges the calculus from the tooth (Figure 3.29). The tooth should never be 'pinched' between the jaws of the forceps as this can result in tooth fracture. Once the majority of the calculus has been removed the remainder can be removed using hand or electromechanical / pneumatic scalers. When the calculus is tenacious the operator should move the scaler on to adjacent teeth to prevent damage to the tooth surface or pulp caused by prolonged scaling. Correct setting of the water (antiseptic) coolant will aid in rinsing of calculus and other debris and will keep the tooth cool. Cavitational energy created by the scaler tip also helps to dislodge the calculus and damage plaque bacteria. Should the scaler be dropped accidentally it should be returned to the manufacturer for evaluation, as bent scaler tips do not scale efficiently. When the operator is satisfied that all calculus has been removed, plaque-disclosing solution can be applied to the teeth to reveal plaque. This will help make polishing more thorough.

The prophy cup or brush should have liberal amounts of polishing paste applied to it as it not only acts as a mild abrasive but also as a lubricant to prevent thermal injury to the tooth (pulp). The prophy cup / brush should have

Figure 3.28 Calculus-cracking forceps make use of shearing forces to dislodge calculus from the tooth / root surface. Do not pinch the crown between the beaks of the forceps or the crown may be severely damaged.

Figure 3.29 Calculus dislodged by correct application of calculus-cracking forceps.

sufficient pressure applied to it to cause flaring or splaying enabling the tip to polish sub-gingivally. Polishing this part of the tooth is essential as it is here that the plaque accumulates initially to become mineralised into calculus.

Polishing all the teeth should not take more than a couple of minutes, following which, the prophy paste and other debris should be gently flushed

from the mouth. The three-way syringe should therefore be used with care, as forceful flushing may cause debris and bacteria to be forced into the oral tissues.

In patients with severe periodontitis evidenced by increased probing depth, it may be beneficial to flush the pockets using an oral antiseptic (See Chapter 7 – Periodontal Surgery.)

Routine maintenance of prophy equipment

Sharpening of hand scalers and curettes

Scalers have two cutting surfaces which must be sharpened on a regular basis. Depending upon use this may be daily or between patients. Place the sharpening stone on a rigid surface (table or work top) and apply the scaler tip to the stone. Using a pull action, with your fourth finger keeping the instrument at the correct angle, draw the instrument across the stone (Figure 3.30). Curettes on the other hand are sharpened by being held firmly in the hand rested on a rigid surface (edge of table or work top). The sharpening stone is then drawn in an arc across the surface of the cutting edge to be sharpened. Natural sharpening stones should be lubricated using oil while synthetic stones must be lubricated with water. Diamond coated sharpeners can also be used (Figure 3.31).

Monitoring scaler tip lengths

Some manufacturers of scaler tips provide a guide to normal scaler tip length. Since it is the apex of the tip which is most efficient at calculus removal it soon

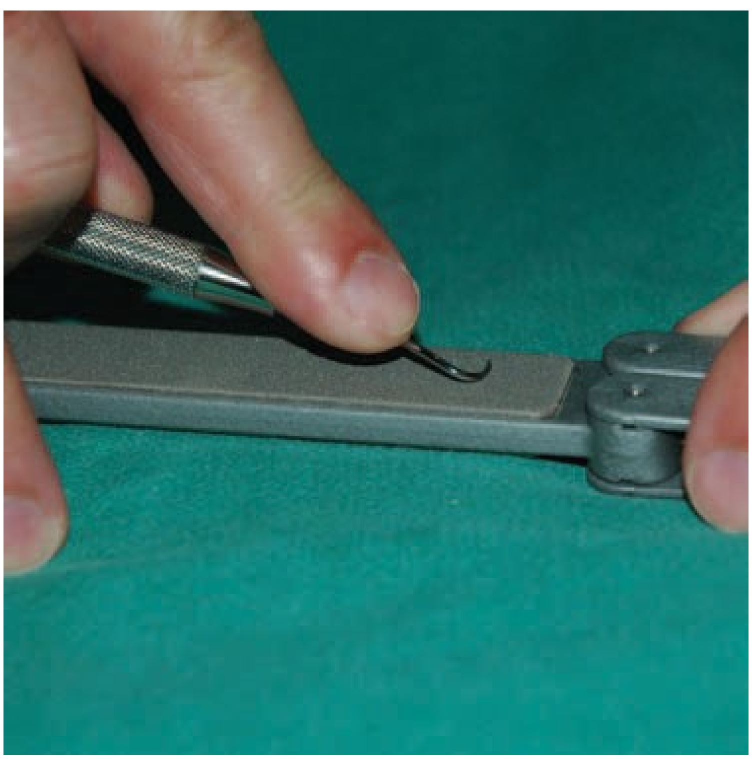


Figure 3.30 Sharpening a dental scaler. Draw the instrument across the stone to prevent bur formation.

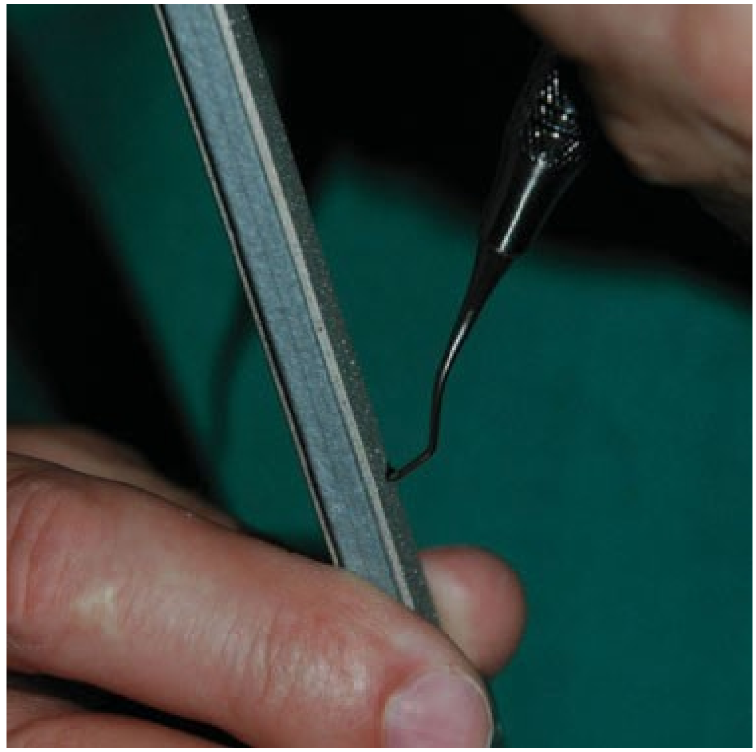


Figure 3.31 Sharpening a dental curette. Draw the stone in an arc across the surface of the curette. A diamond sharpener is being used here.

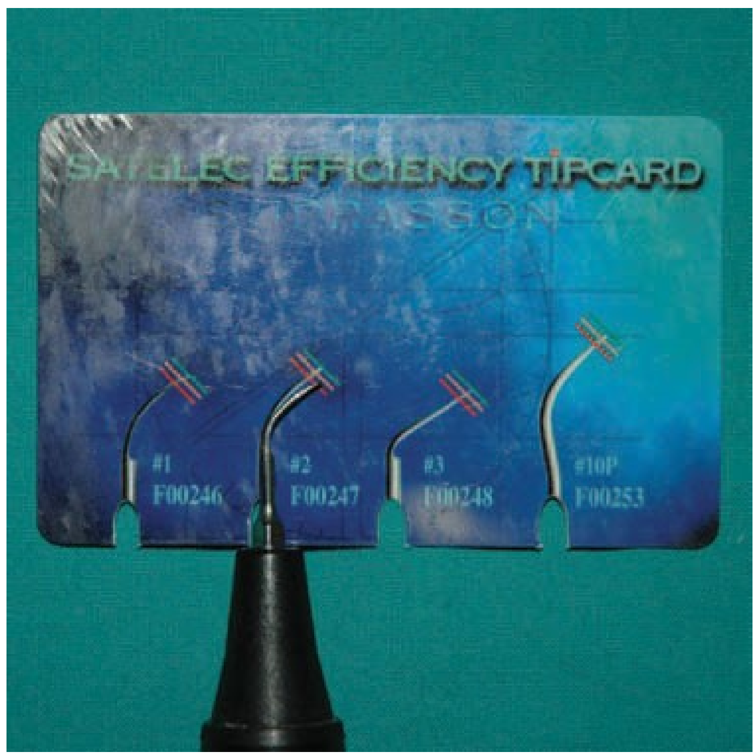


Figure 3.32 Ultrasonic scaler tips wear due to the friction of calculus and must be replaced when worn. The tip in this figure is near replacement. Short tips are ineffective (tips which have become bent after being dropped are also likely to be ineffective).

becomes worn and the tip must be replaced at the manufacturer's recommendation (Figure 3.32). If the scaler is dropped and the tip becomes bent as a result it should be returned to the supplier for evaluation as many tips will become ineffective when bent. Dropping the hand piece can also cause severe damage to the magnetostrictive and piezoelectrical components.

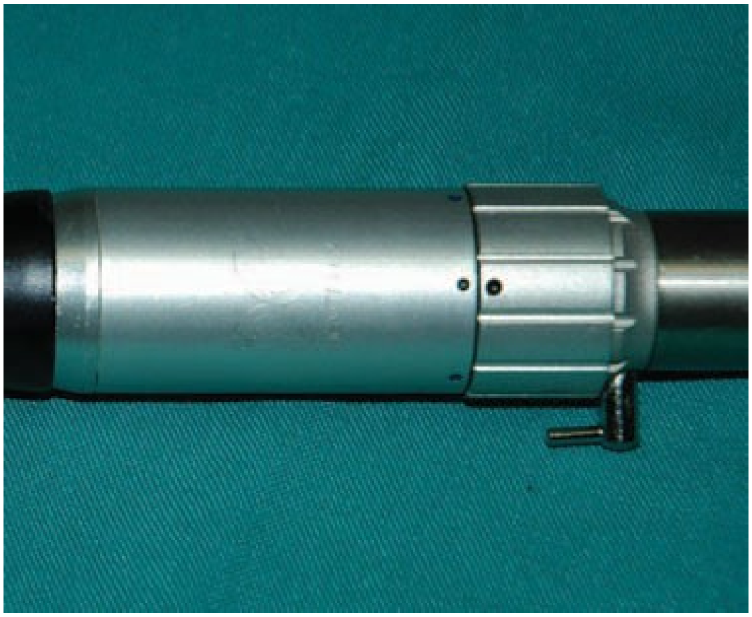


Figure 3.33 The direction collar at the base of the air polisher must be set to run in the correct direction. Hair and other foreign material can be 'unwound' from the prophy hand by changing the direction of rotation.

Maintenance of polishers

The E-type fitting of the air motor as well as the contra-angle polishing attachment must be oiled on a regular basis for optimum function. The small flange at the base of the snap-on button may accumulate material, including hair. This material is easily removed by unscrewing the prophy button. Sometimes by reversing the direction of rotation of the head the material can be unwound (Figure 3.33).

Maintenance of high-speed turbine

The high-speed turbine must be oiled regularly according to the manufacturer's instructions since over or under oiling can be detrimental to this refined piece of equipment. Some turbines may be subjected to autoclave sterilisation while others may be sterilised using disinfectants (cold sterilisation) depending upon manufacturer's instructions. The turbine must never be run without a bur or blank in the chuck as this will cause severe damage to the turbine head. Oil is placed in the narrower of the two large holes at the back of the hand piece (Figure 3.34).

Sharpening luxators and elevators

Luxation instruments are sharpened to a fine point, with the concave part of the instrument applied to the sharpening stone (Figure 3.35). It is essential that the curvature of the sharpening stone is the same as that of the luxation instrument or it will be damaged irreversibly. If the curvature of the sharpening stone exceeds that of the luxation instrument it will become flattened and lose its shape.

Elevators are sharpened on the convex side at a less acute angle. The convex side of the elevator must be placed on the sharpening stone at the correct

Figure 3.34 Rotary dental equipment must be lubricated according to manufacturer's instructions using an approved lubricant. Over lubrication can be detrimental.

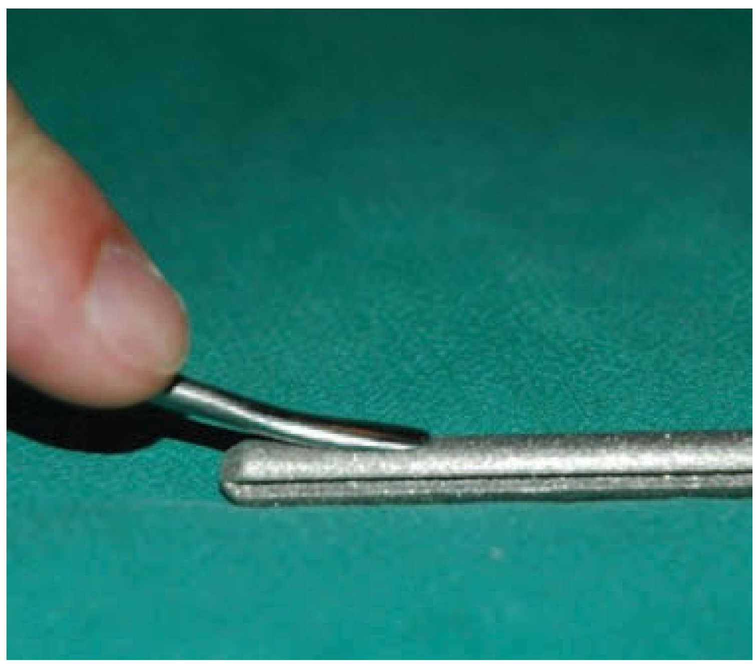


Figure 3.35 Luxators should be sharpened on their concave surfaces using a sharpening stone or file of equivalent curvature. The instruments are sharpened by pushing them along the sharpening rod. Using a sharpening device of inappropriate size will shorten the life of the instrument.

inclination and using a back-and-forth wrist action, gently 'wiped' across the stone (Figure 3.36).

Sharp elevators and luxation instruments are less likely to inflict damage as they engage the ligament and rarely slide off the alveolar bone which would traumatise adjacent soft tissue (Figure 3.37).

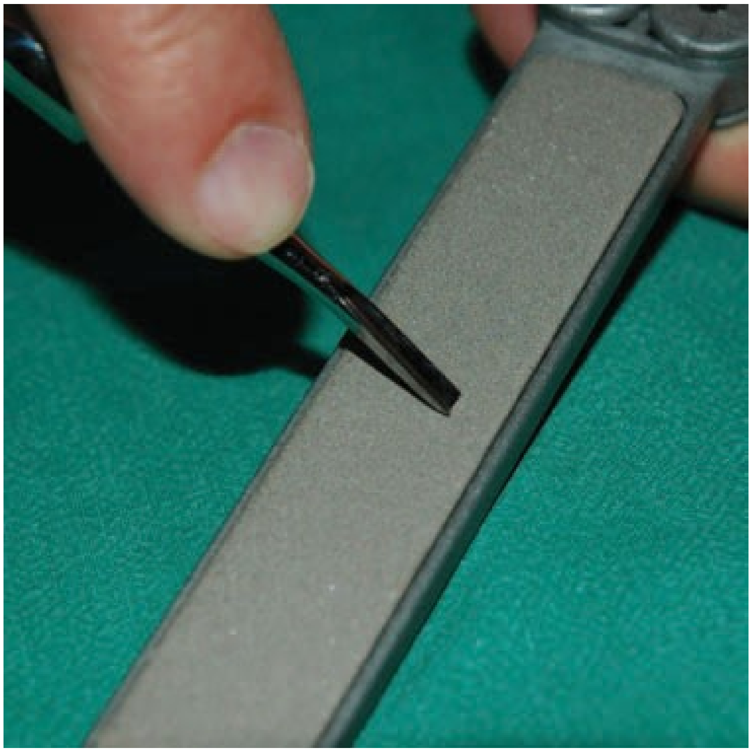


Figure 3.36 Elevators should be sharpened on their convex surface at the correct angle to maintain the tip shape. Using a wrist action the tip is wiped back and forth.

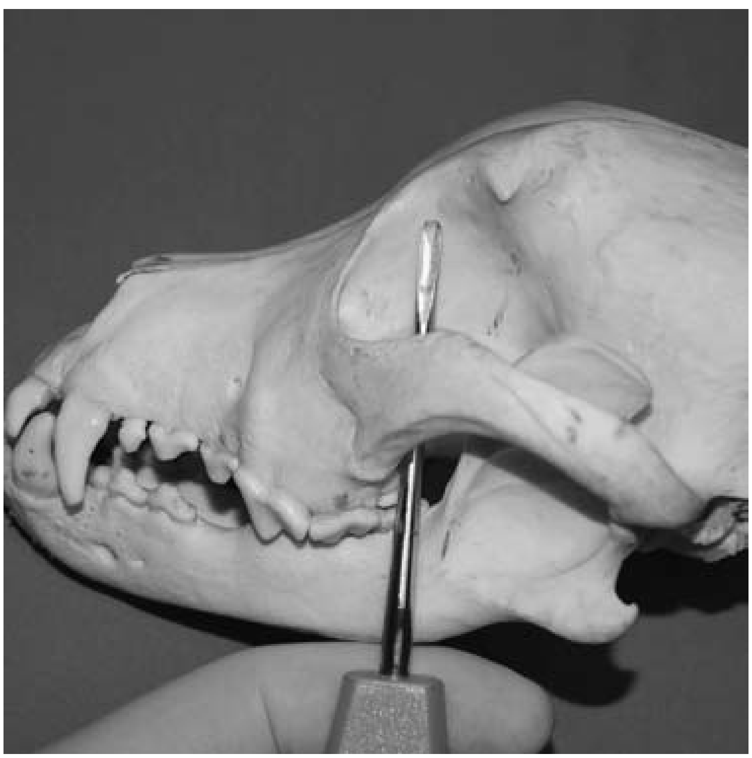


Figure 3.37 Luxators and elevators must be held in such a manner that the index finger is extended along the shaft of the instrument, to prevent inadvertent injury should the instrument slide off the alveolar bone / tooth surface. Intra-cranial and intra / retro-bulbar injuries are serious consequences of such accidents.

Further reading

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Holstrom, S.E., Frost, P. and Eisner, E.R. (1998) *Veterinary Dental Techniques for the Small Animal Practitioner* (2nd edn). W.B. Saunders Company, Philadelphia.

Wiggs, R.B. and Lobprise, H.B. (1997) *Veterinary Dentistry Principles and Practice*. Lippincott–Raven, Philadelphia.

4 Radiography

Indications for dental radiography

It is not possible to practice veterinary dentistry to an acceptable standard without using radiography as an aid to diagnostics, for treatment planning and monitoring.

Discoloured, fractured, clinically missing, abnormally shaped or placed, worn and loose teeth should all be radiographed. Prior to the extraction of teeth, for whatever reason, a radiograph should be obtained. Depending on the results, the initial treatment plan may need to be modified. For example, the tooth may have a supernumerary root or fused roots or it may have a sub-gingival fracture requiring a different extraction plan of action. Swelling in the mouth (from hyperplastic gingival lesions to more aggressive lesions) should be radiographed to determine what bony changes have occurred. Radiography also gives an indication of the presence or absence of the periodontal ligament space and whether the tooth is likely to be ankylosed to the bone or not. In some cats affected by odontoclastic resorption and replacement, the entire root of a tooth may have been resorbed and replaced by bone with only the crown remaining. Extraction of such teeth is markedly different from routine extractions (Figures 4.1–4.18).

Figure 4.1 Teeth associated with inflamed gingiva should be radiographed. In this case stage 3 Feline Odontoclastic Resorption was diagnosed in this cat mandibular right third premolar.

Figure 4.2 The gingiva attached to the occlusal surface of this dog mandibular right first molar prompted radiography that lead to the diagnosis of odontoclastic resorption in this tooth.

Figure 4.3 This chronic oro–nasal fistula resulted from chronic periodontitis affecting the maxillary left canine and premolars. Radiographs were taken to eliminate the presence of root remnants and evaluate the bony palate. There was no bone supporting 206.

Figure 4.4 This fistula is a remnant of extraction of a periodontally compromised maxillary right canine tooth. Radiography confirmed that there were no root remnants present before the surgical repair was undertaken.

Figure 4.5 This draining sinus tract was found to be leading from a periapical abscess involving the mandibular left canine in this cat.

Figure 4.6 This sinus tract was associated with periapical pathology following a complicated crown fracture of the maxillary right deciduous canine in this young puppy.

Figure 4.7 Although this sinus tract is at the level of the maxillary right second premolar, it led to the root of the maxillary right canine tooth which had a complicated crown fracture. There are two sinus tracts dorsal to the carnassial tooth associated with the buccal roots of this tooth which also had a complicated crown fracture.

Figure 4.8 Severe periodontal lesions should be radiographed.

Figure 4.9 There is horizontal bone loss affecting the teeth in this mandibular left quadrant. Taking radiographs will reveal the extent of these lesions.

Figure 4.10 Taking radiographs of teeth similar to this will show if the teeth are periodontally sound.

Figure 4.11 Although the mandibular right canine and premolar 3 have obvious chronic complicated crown fractures, taking radiographs will eliminate unpleasant surprises during extraction.

Figure 4.12 The maxillary second incisor had an acute complicated crown fracture. A pre-operative radiograph was taken to eliminate further sub-gingival fractures prior to root canal therapy on this tooth. The supernumerary maxillary left incisor 2 was an incidental finding.

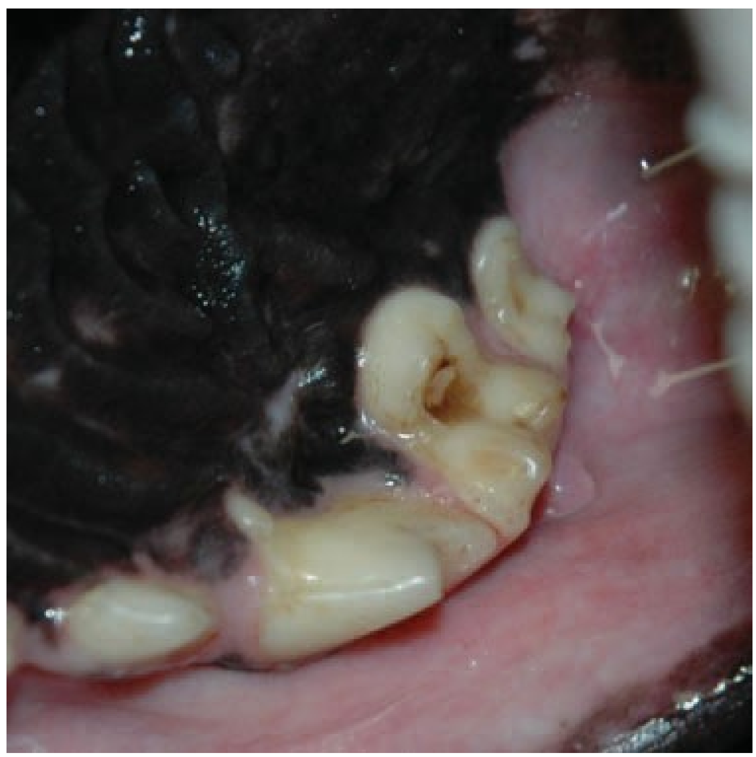


Figure 4.13 Discoloured teeth should be explored and radiographed to eliminate caries and pulp exposures. This is a case of arrested caries in 109.

Figure 4.14 The maxillary right lateral incisor in this six-year-old Doberman became acutely discoloured. Periapical pathology as a result of pulpitis / pulp necrosis must be ruled out.

Figure 4.15 Teeth with extra cusps similar to that seen on the maxillary right premolar 3 are often associated with a supernumerary root. Radiography will confirm / rule this out.

Figure 4.16 The maxillary right second incisor has undergone gemination. This can be confirmed on radiography and the extent of separation of the roots can be evaluated as well.

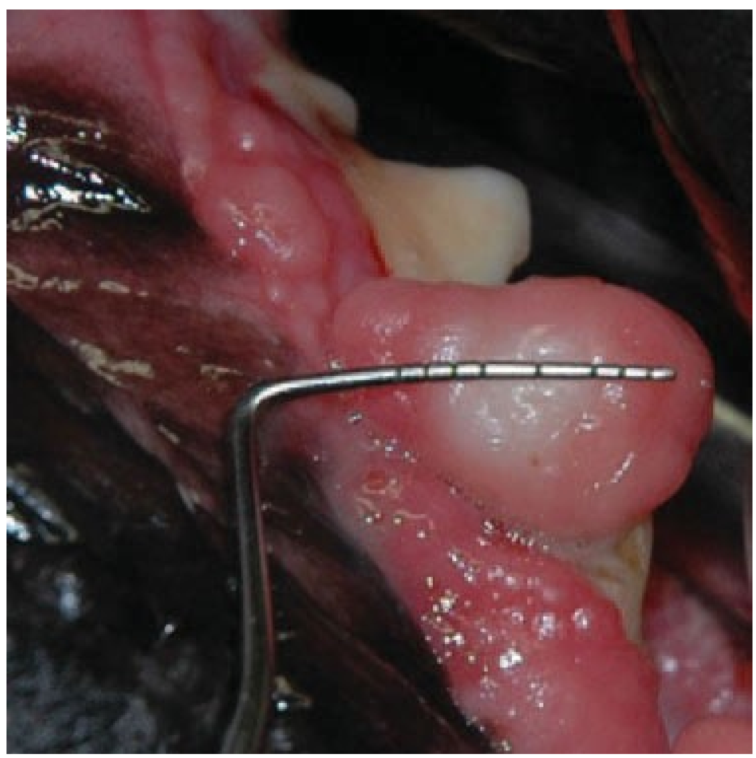


Figure 4.17 Epuli should be radiographed to determine the extent of bony involvement.

Figure 4.18 Oral soft tissue tumours often invade underlying bone which can be confirmed radiographically.

Figure 4.19 A medical X-ray machine can be used to take diagnostic dental radiographs.

Equipment

Veterinary dental radiography can be performed using the medical X-ray machines (Figure 4.19) found in most private veterinary practices but dental X-ray machines (Figure 4.20) are more practical.

Figure 4.20 Dental X-ray machines are easily positioned around the patient and can be installed in the dental theatre.

The disadvantages of using a medical X-ray machine:

- the machine is usually situated in a separate room, away from the dental room
- the anaesthetised patient needs to be moved between the dental and X-ray rooms to be positioned under the X-ray machine
- some machines are fixed to the wall and cannot be lowered to the required film focal distance (FFD)
- some machines are not able to swivel to be positioned for correct bisecting angle techniques
- collimation and positioning the X-ray head is often cumbersome
- settings are arrived at by trial and error.

Advantages of using a dental X-ray machine:

- the FFD is fixed by the tube collimator
- collimation is accurate and safe
- usually kV and mA are fixed, requiring only time to be set
- machine is positioned around patient
- machine may be mobile or mounted on the wall or ceiling of the dental room.

When using a medical X-ray machine it should be set at about 70 kV and 15–25 mA depending upon the size of the patient and the structures to be

Figure 4.21 Hand-developing tanks can be used to develop dental X-ray film. The film must be well secured during processing as retrieving it from the bottom of these tanks is challenging!

Figure 4.22 Processing chemicals can be decanted from the automatic processor into receptacles and used in the darkroom.

radiographed. The FFD should be about 40 cm and can be attained either by lowering the X-ray machine head or placing an object (low table or other suitable object) on the X-ray table onto which the patient is placed. Intra-oral film can be used and can either be developed in the developing tanks (Figure 4.21), small receptacles in the dark room (Figure 4.22), or in a chair-side darkroom (Figures 4.23–4.24).

Figure 4.23 Chair-side 'darkrooms' are convenient processing chambers.

Figure 4.24 The red 'window' provides 'safe' light within the processor allowing visualisation of the process.

Dental X-ray machines usually have a fixed kV of between 50 and 70 and mA of 7 or 8. Exposure time is adjustable and may be set mechanically or electronically. Some collimators are conical while others are lead-lined cylinders (the former are considered undesirable because of increased danger of scatter radiation). Some newer dental X-ray machines make use of a rectangular collimator with a cross-sectional area not much larger than the intra-oral film. This reduces scatter radiation.

Health and safety considerations

Although the health and safety specifications of some dental X-ray machines state that it is safe to be within 600 mm of the back of the tube head and 1.8 m in front of the tube head, it is advisable to vacate the room while dental radiographic exposures are made. This requires installation of an extended or remote release button. Under no circumstances should the operator or assistant find themselves within the primary X-ray beam. The advice of your local ionizing radiation safety official must be sought when planning the installation of a dental X-ray unit. Ideally, the dental operatory should have walls of brick and mortar and the door should be lead lined to increase the level of ionizing radiation safety. A 'do not enter' sign should be illuminated when X-ray exposures are being made in the dental operatory.

Intra-oral dental film

Intra-oral dental film is non-screen film available in four sizes of which the adult periapical (3.1 × 4.1 cm), paediatric periapical (2.4 × 4.0 cm) and occlusal (5.7 × 7.6 cm) films are most commonly used (Figure 4.25). These films are usually packed in impervious 'envelopes' which are clearly marked to show which side is the back. Each envelope contains a lead backing sheet and a black protective paper surrounding the film (Figure 4.26). (Some film packages, for example the ECO 30™, do not contain a lead backing sheet.) Most films have a raised nodule near one corner of the front of the film which aids in orientation of the film during viewing (Figure 4.27). Ideally, this nodule should not coincide with an area of importance to be radiographed or it may lead to artefact interference with interpretation of the radiograph. There are two speeds of film commonly available viz. Ekta™ or E-speed and Ultra™ or D-speed. E-speed film must be developed under an orange safe light or it will become overexposed. E-speed film requires a lower exposure setting but

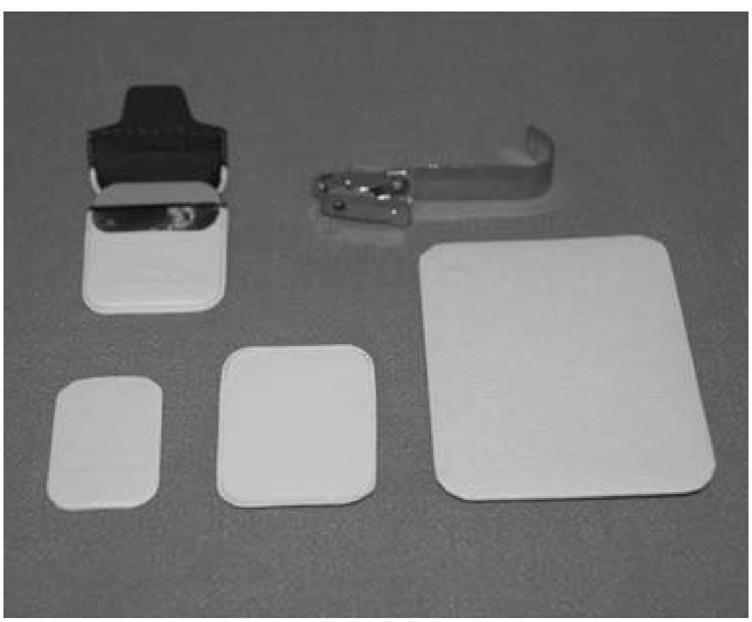


Figure 4.25 The most commonly used sizes of intra-oral dental film are from left: paediatric periapical, adult periapical and occlusal film. A dedicated processing clip is visible above the film.

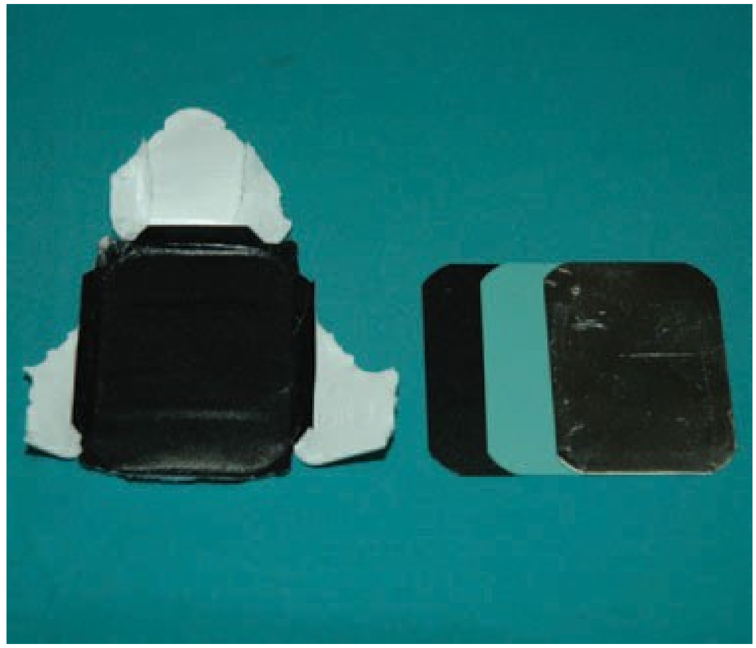


Figure 4.26 The film is protected by black paper. A lead backing sheet eliminates scatter radiation and the film is sealed in a plastic envelope.

Figure 4.27 The film has a small nodule on the right upper corner used to orientate it after processing. The film on the left is exposed but not developed.

gives an image of lesser quality. D-speed film can be developed under red safe lighting.

Mammography film in normal mammography cassettes can be used to take radiographs of teeth and other oral structures but care must be exercised during positioning to prevent superimposition of structures. These cassettes are used extra-orally. Plastic envelope cassettes can be used for intra-oral radiography.

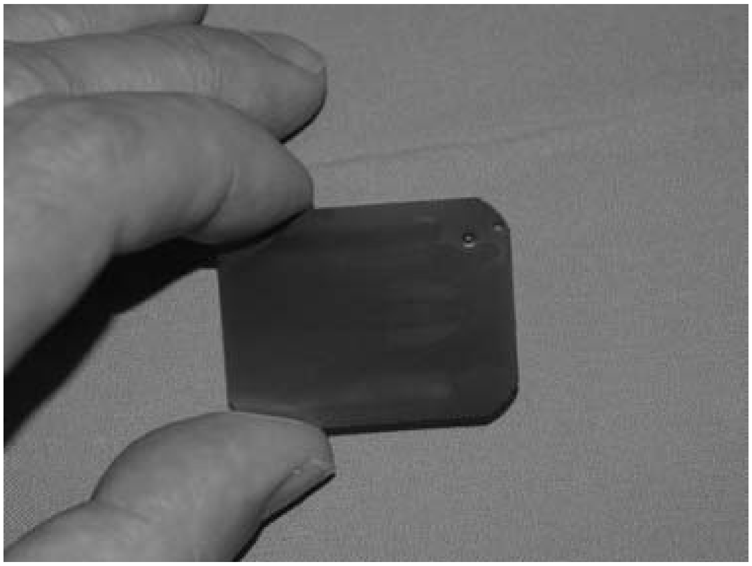


Figure 4.28 The X-ray film / radiograph should be held along its edges to prevent fingerprint artefacts.

Film processing

Chair-side 'darkrooms' are ideal for developing intra-oral dental film as they can be positioned close to the patient and the processed radiograph can be viewed within two minutes of being taken. These 'darkrooms' have either three or four containers within them. The four-container system contains: developer, rinse water, fixer and rinse water. The three-container system contains: developer, rinse water and fixer. The film is rinsed in the same water after developing and fixing. Small purpose-made clips should be used to hold the films during processing. If these are not available small haemostat forceps can be used instead. Automated processors are also available. Where processing tanks are used in a practice the dental film can be developed in the darkroom, but this requires the nurse or veterinary surgeon to be away from the patient periodically. If the practice uses an automated processor (for their routine radiographs), developer and fixer chemicals can be decanted from the processor and used as a three-container system within the darkroom. Processing chemicals differ and the duration of developing and fixing varies according to the chemicals used. When using rapid-acting chemicals, developing and fixing routinely take about 30–40 seconds per process. These chemicals are used at room temperature, however when the ambient temperature is low the process will take slightly longer. Other chemicals require up to 2.5 minutes for developing and the same length of time for fixing.

The dental film should be handled along its edges to prevent finger prints causing artefacts (Figures 4.28 and 4.29).

Film positioning

To take a full-mouth set of radiographs in the cat will require a minimum of ten films: one for upper incisors and canines (rostro-caudal view), two for upper canines (latero-medial view), two for upper premolars and molars, one for lower incisors and canines (rostro-caudal view), two for lower canines (latero-medial view) and two for lower premolars and molars. However for

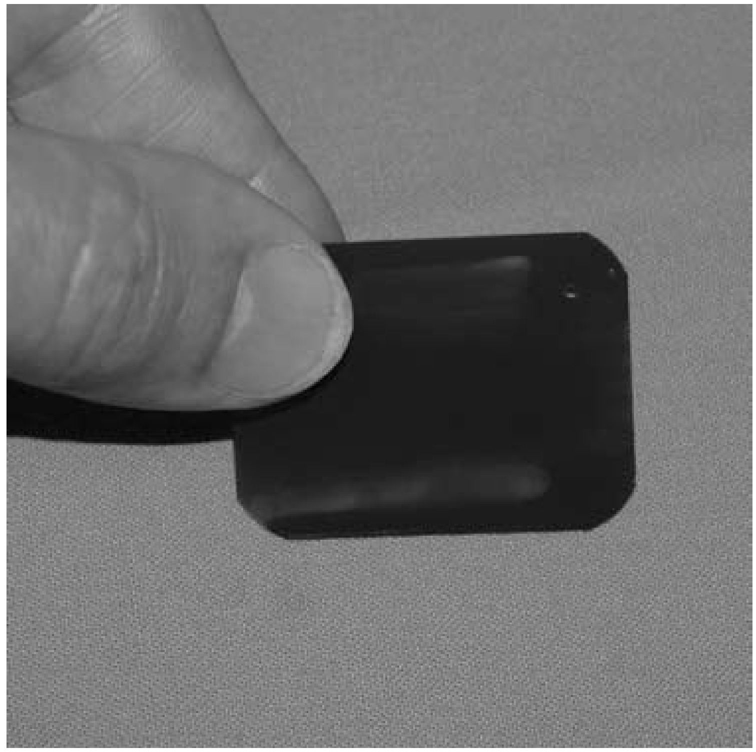


Figure 4.29 Holding the X-ray film / radiograph in this manner will lead to fingerprint artefacts.

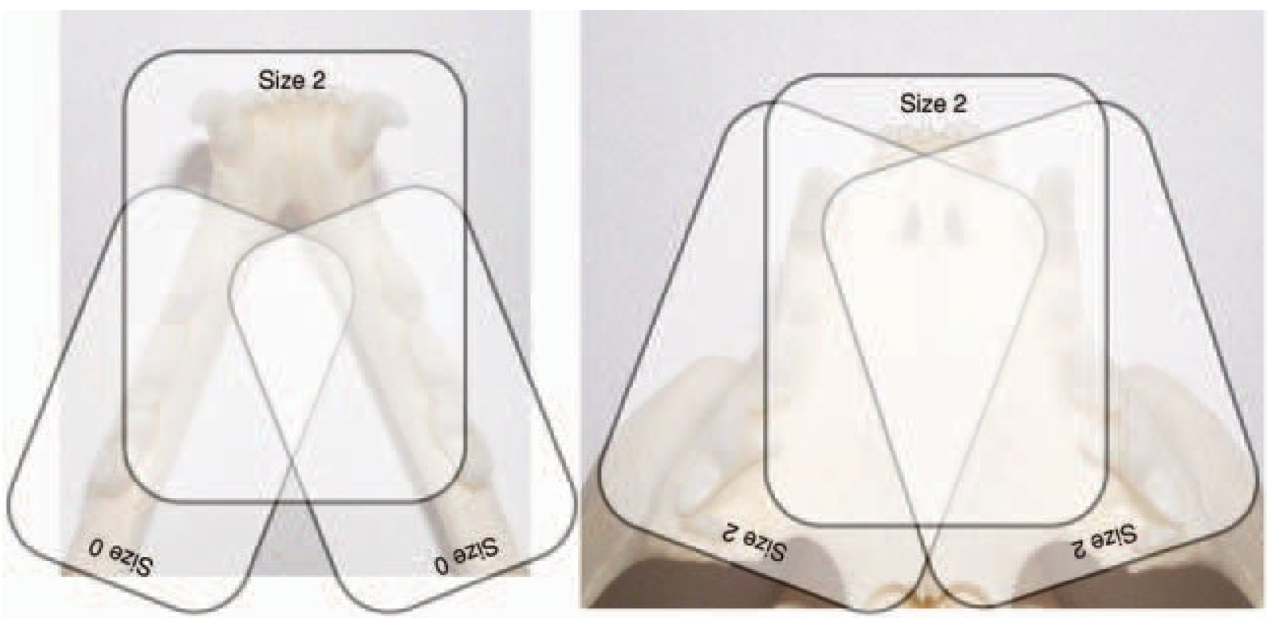
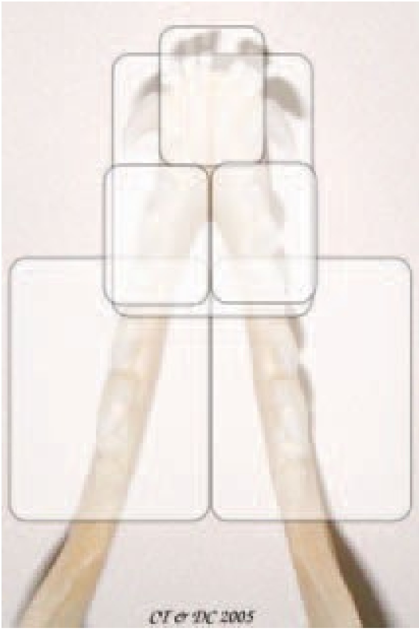


Figure 4.30 Illustration of positioning of intra-oral radiographic film for a survey series of dental radiographs in a cat.

screening purposes six views can be taken and, depending on the outcome, further views can be taken (Figure 4.30).

To take a full-mouth set in medium to large dogs will require a further four to six films depending upon the size of the dog (Figures 4.31 and 4.32).

In some dogs where the incisors are arranged in an arc (rather than being in a fairly straight row), it may be necessary to take radiographs of the left and



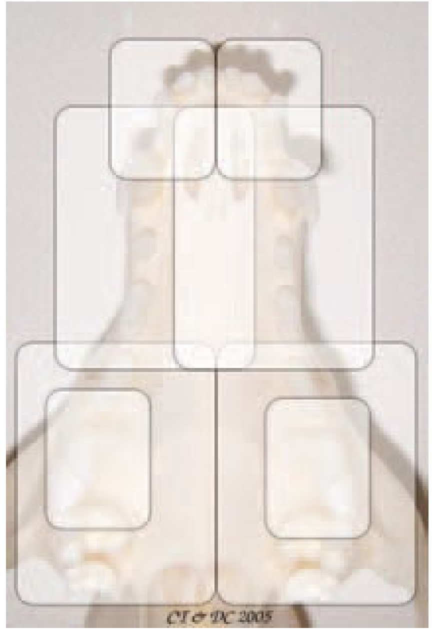


Figure 4.31(*left*) Illustration of positioning of intra-oral radiographic film for a survey series of dental radiographs of the dog mandibles.

Figure 4.32(*right*) Illustration of positioning of intra-oral radiographic film for a survey series of dental radiographs of the dog maxillae.

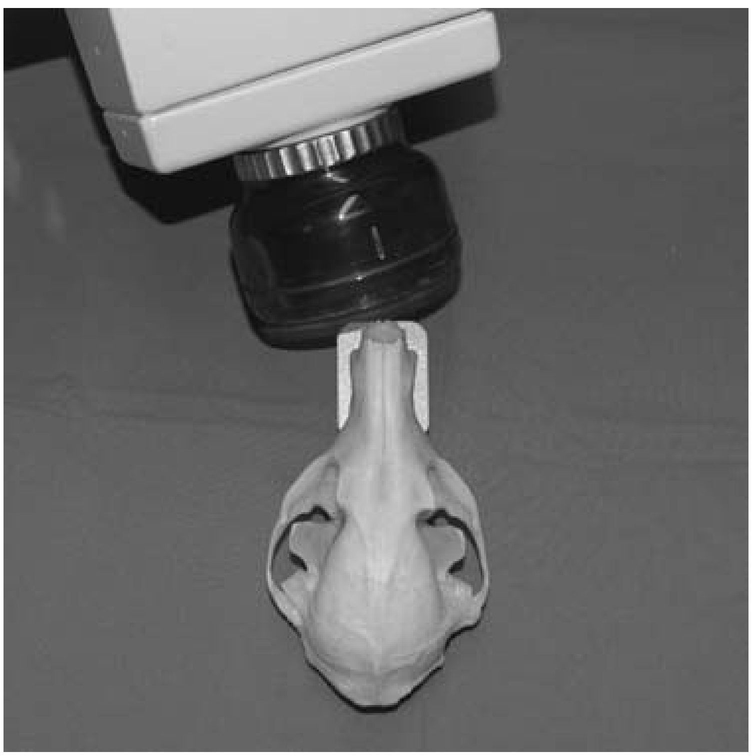


Figure 4.33 By positioning the X-ray head to one side, superimposition of the maxillary incisors can be prevented.

right incisors separately to prevent superimposition of the roots (Figures 4.33 and 4.34).

Two film positioning techniques are used, namely the parallel and bisecting line techniques.

Figure 4.34 The view obtained by the positioning chosen in Figure 4.33.

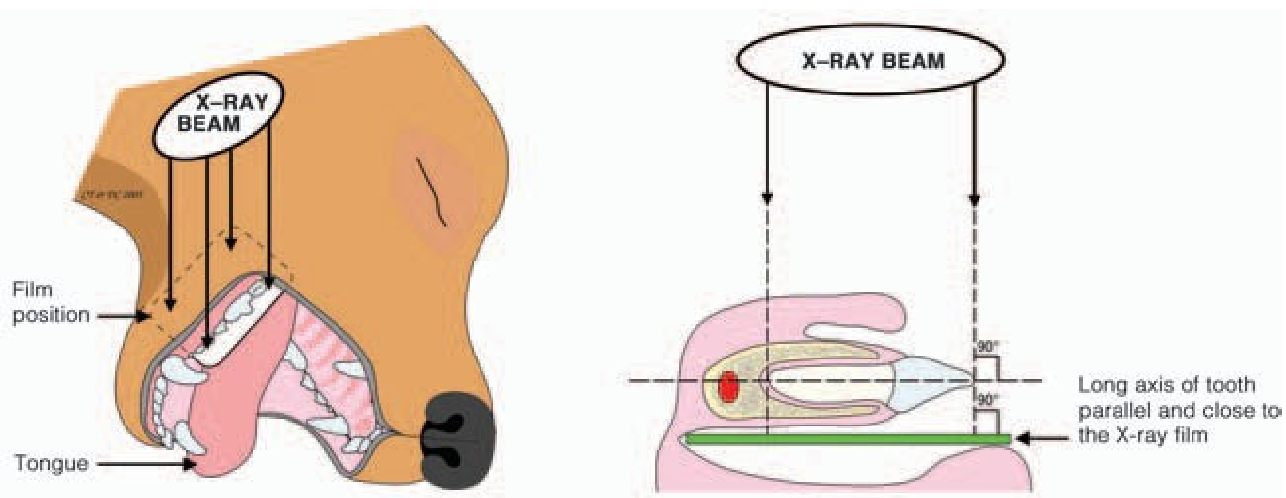


Figure 4.35 Illustration of the parallel radiography technique. The film is placed close and parallel to the teeth and the incident beam is directed perpendicular to the teeth and film.

Parallel technique

The parallel technique is used to take intra-oral radiographs of mandibular teeth caudal to the second premolar in dogs. In some patients the second premolar can be included on the first film. In cats the mandibular third and fourth premolar and first molar teeth are imaged using the parallel technique. The dental film is placed between the teeth and the tongue, with the film projecting below the ventral margin of the mandible. The incident X-ray beam is then directed perpendicular to the teeth and the film giving a realistic image of the teeth on the radiograph (Figures 4.35–4.38). The parallel technique can also

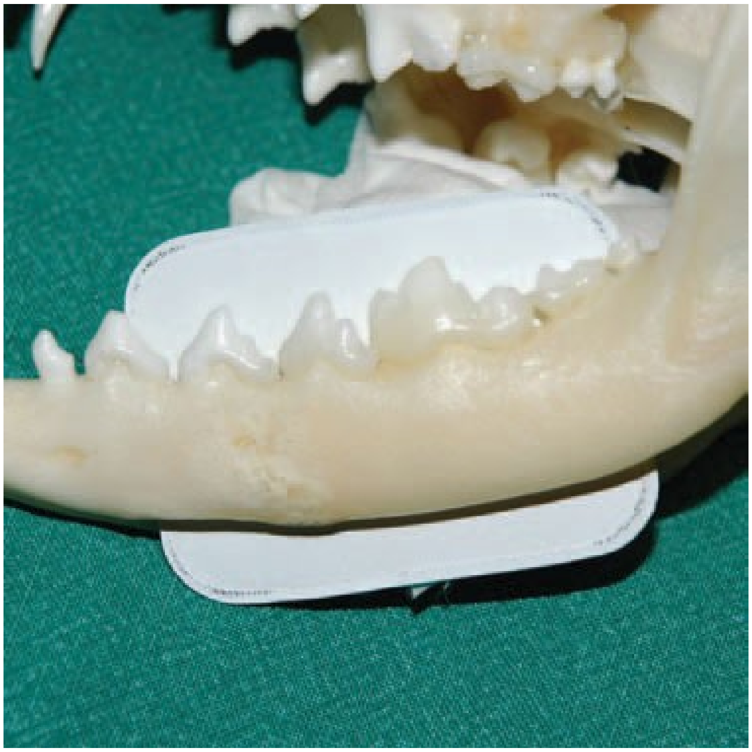


Figure 4.36 Parallel technique. The film must protrude beyond the ventral margin of the mandible to include this on the radiograph.

Figure 4.37 Parallel technique. Paper towel can be used to keep the film close to the teeth.

be used to radiograph the maxillary carnassial tooth with the film placed in an extra-oral position. The mouth must be propped open to prevent superimposition of other structures on the tooth being radiographed (Figure 4.39). If this technique is used, the radiograph should be annotated accordingly as this

Figure 4.38 The film must be placed close and parallel to the teeth.

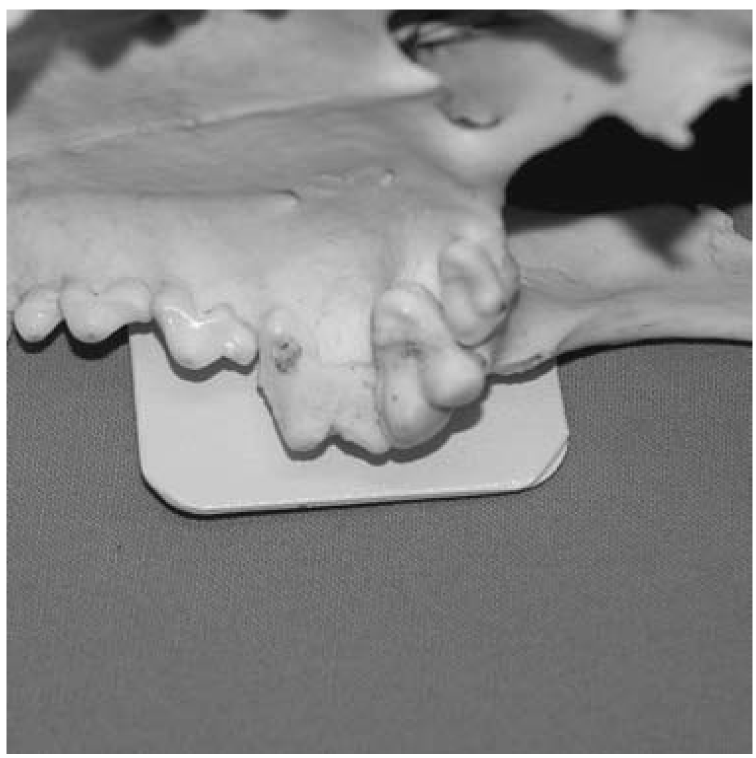


Figure 4.39 Radiographing the maxillary carnassial tooth using the parallel technique requires extra-oral placement of the film. A dog skull is used for illustration.

radiograph will resemble that taken of the contra-lateral maxillary carnassial using the intra-oral placement technique.

Bisecting line technique

The bisecting line technique is used to image the remaining teeth in the mouth, where the film cannot be placed parallel to the teeth. The angle created by the film axis and the tooth axis is bisected and the incident X-ray beam is directed perpendicular to the bisecting line (Figures 4.40–4.44). If the incident beam is

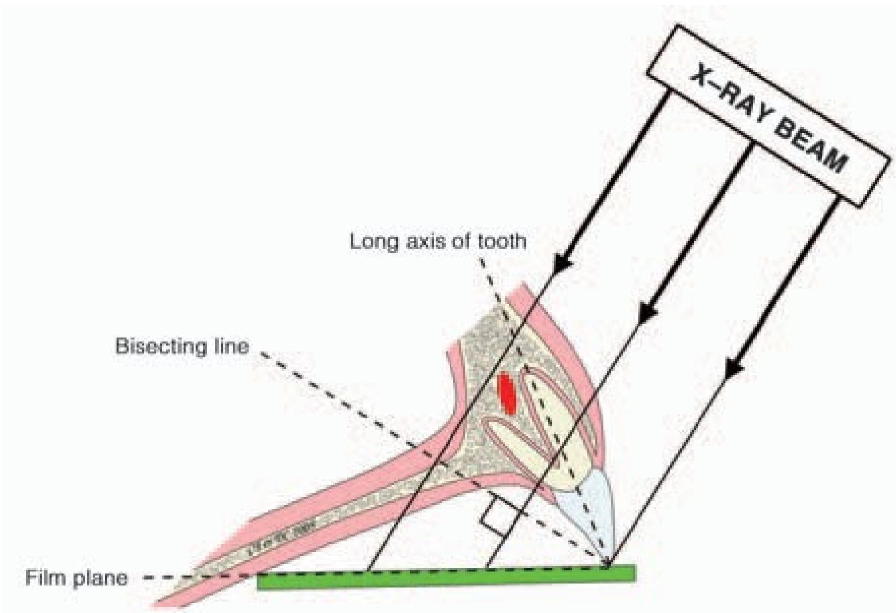


Figure 4.40 Bisecting line technique. The angle formed by the tooth and film axes is bisected. The incident beam is directed perpendicular to the bisecting line.

Figure 4.41 Bisecting line technique. Film placement for maxillary premolars and molars.

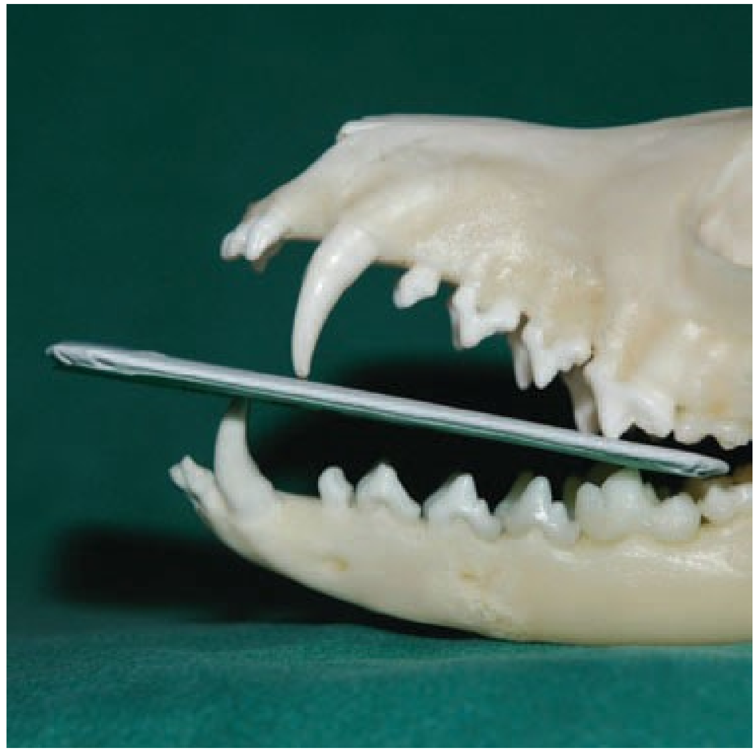


Figure 4.42 Bisecting line technique. Film placement for maxillary incisors and canine teeth.

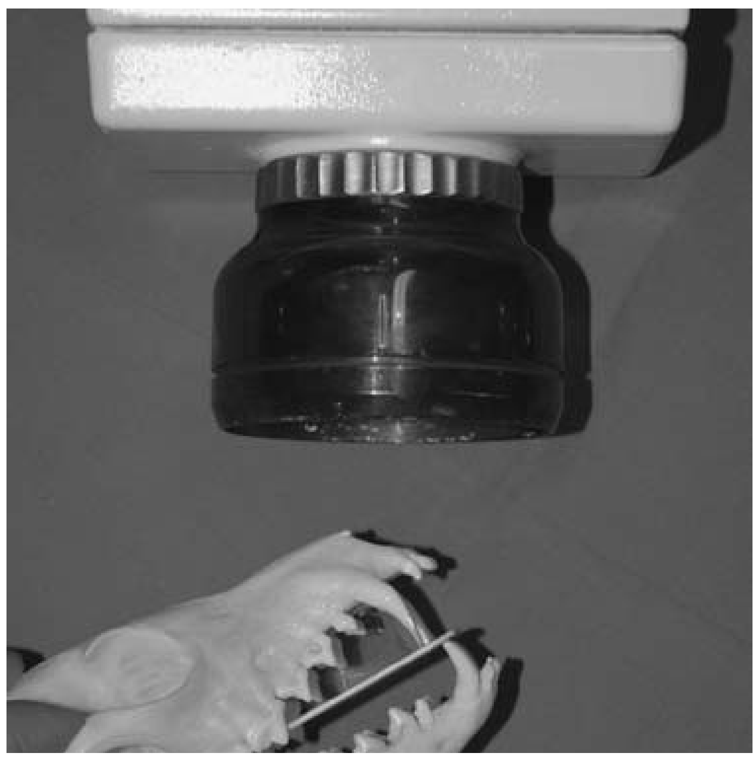


Figure 4.43 Bisecting line technique. Film and X-ray head placement for radiography of the maxillary incisors.

perpendicular to the tooth surface, the image will be lengthened (elongation) (usually with the apex off the edge of the film); if the incident beam is perpendicular to the film, the image will be shortened (foreshortening). If a tooth is longer than the film available, two radiographs should be taken to evaluate the whole tooth.

Figure 4.44 Radiograph obtained from the positioning in Figure 4.43.

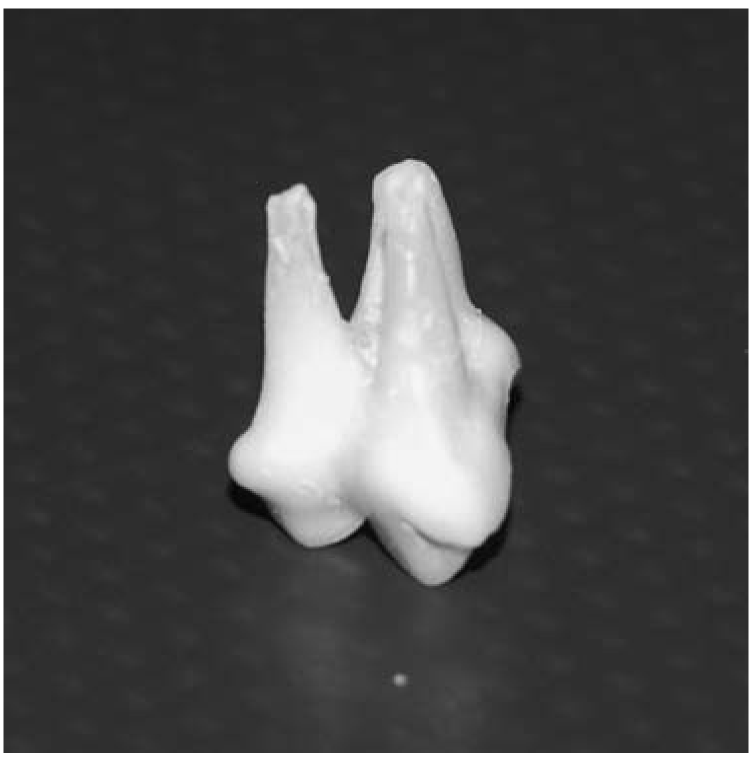


Figure 4.45 Superimposition of structures can complicate diagnosis. Here the mesial root is superimposed on the palatal root.

Superimposition of structures

By changing the angle of the incident beam, superimposed structures (Figure 4.45) can be separated. The SLOB (same lingual opposite buccal) rule is applied to superimposed structures and defines the direction in which the

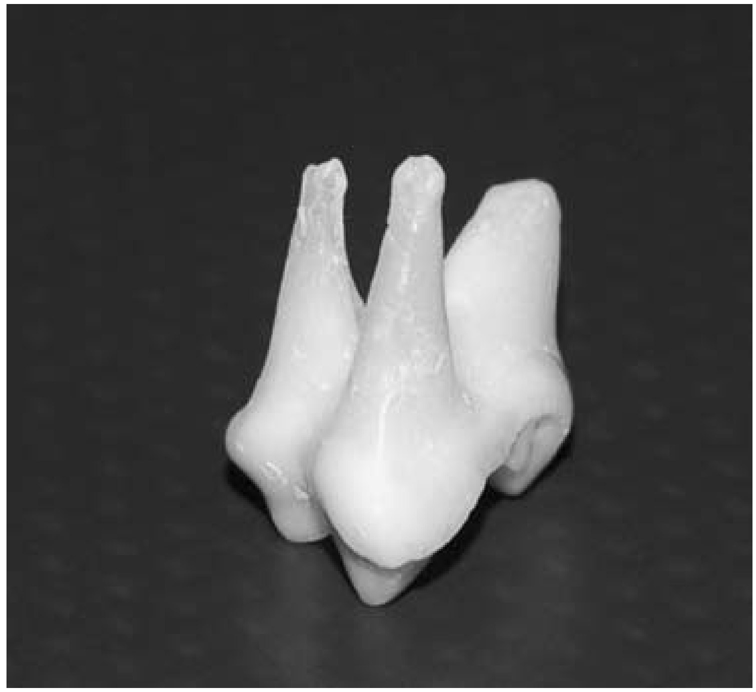


Figure 4.46 By moving the incident beam to a more rostral position, the palatal structure 'moves' to a more mesial position.

Figure 4.47 By moving the incident beam caudally, the mesio-buccal root 'moves' to a more mesial position.

different structures move in relation to the movement of the incident beam. A structure which moves in the same direction as the incident beam is positioned on the lingual / palatal side. For example, considering the maxillary carnassial tooth. If the incident beam is directed from a more rostral position the palatal root will be the most mesial of that tooth's structures on the new radiograph (Figure 4.46). Conversely, if the beam is directed from a caudal position the structure which moves in the opposite direction to become the most mesial structure of the tooth on the new radiograph will be the mesio-buccal root (Figure 4.47).

Figure 4.48 Crown and root elongation occurs when the incident beam is tending to be perpendicular to the tooth axes.

Correcting elongation and foreshortening

An elongated tooth (Figure 4.48) results from an incident beam tending towards being perpendicular to the tooth surface (Figure 4.49). To correct this, the beam should be angled at an obtuse angle to the tooth surface (Figure 4.50).

A foreshortened tooth (Figure 4.51) results from an incident beam tending towards being perpendicular to the film axis (Figure 4.52). To correct this, the beam should be incident at an acute angle to the film axis (Figure 4.53). Knowledge of root anatomy will aid in positioning of the dental film and direction of the incident beam to produce an accurate diagnostic image of the tooth under examination.

Digital imaging

There are a number of veterinary practices making use of digital dental imaging systems. There are two systems: direct – where the image is captured by a sensor and sent to the computer screen – and indirect – where the image is captured on a phosphorescent plate that must be read by a laser reader and then digitised. The direct system projects the image on a computer screen (Figure 4.54) after it has been captured by a sensor (Figure 4.55). This takes the place of the intra-oral dental film.

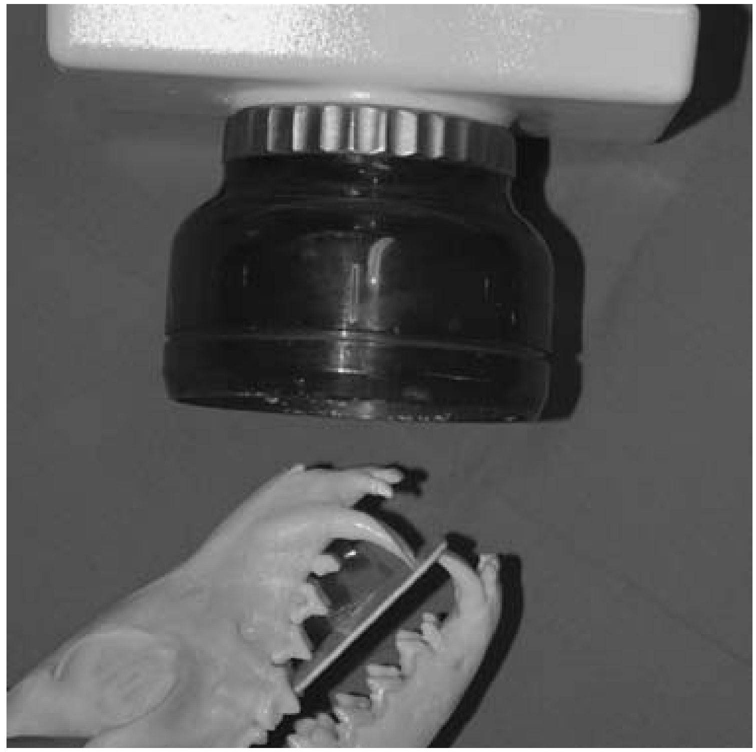


Figure 4.49 The X-ray head is positioned perpendicular to the incisor teeth axes resulting in elongation.

Figure 4.50 Correct position for radiographing maxillary incisors.

Figure 4.51 Foreshortening occurs when the incident beam is tending to be perpendicular to the film axis.

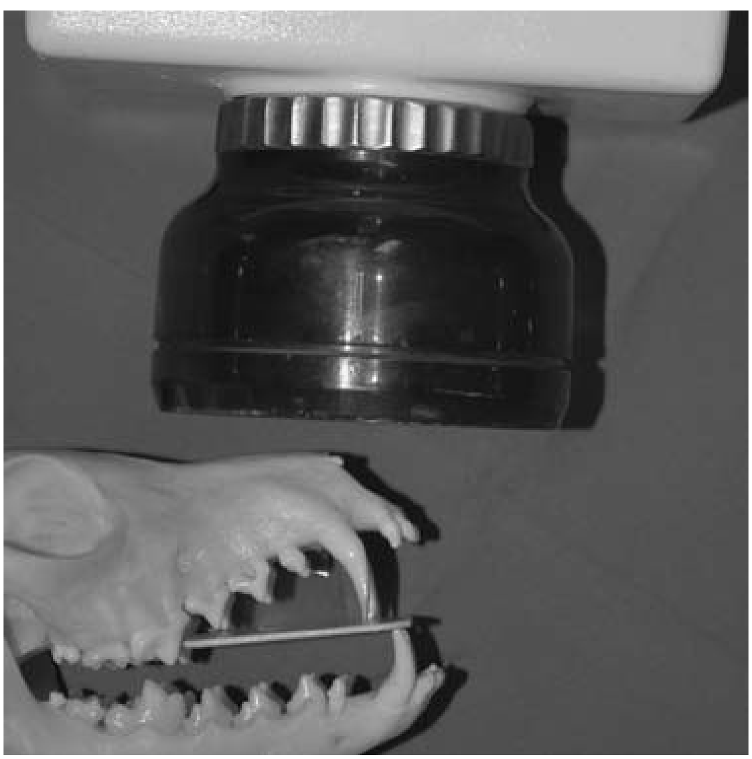


Figure 4.52 X-ray head placement which will lead to foreshortening of the maxillary incisors.

Figure 4.53 Correct position for radiographing maxillary incisors.

There are a number of advantages to this system including:

- speed of use (image on screen within seconds)
- minor adjustments can be made to the position of the sensor if image is not correct on screen, without having to reposition the X-ray machine
- images can be enhanced and digital storage of patient records is facilitated.

Disadvantages include:

- price of the equipment and the size of the sensor

  The use of this technology in cats is complicated by positioning of the sensor as it is not flexible and is thicker than the intra-oral X-ray film envelope. 'Burnout' is sometimes seen even at low exposure settings, and by increasing the X-ray generator sensor focal distance this can sometimes be alleviated.

Radiology

Dental radiographs are usually mounted using the lingual or buccal view. By convention, veterinary dental radiographs are mounted using the buccal view. This means that the radiographs are mounted with the incisal edges of teeth in opposing arcades facing each other as viewed from the front of the animal. This means that the patient's right arcades will be to the left of the set and the left arcades will be to the right of the set (Figure 4.56).

Figure 4.54 Digital X-ray images are transferred to the computer screen within seconds of exposure.

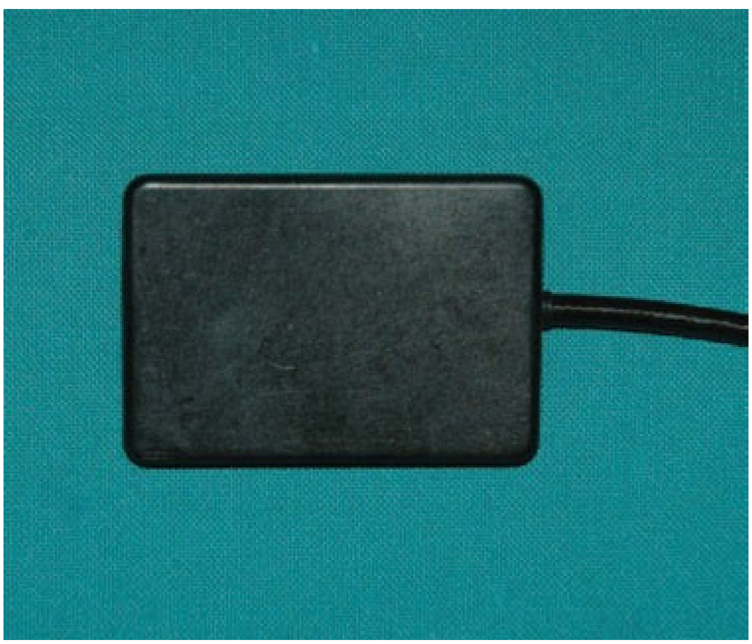


Figure 4.55 A size 2 digital dental-imaging sensor.

Dental radiographs should be examined in a dark room, preferably with light passing through the radiograph alone (no peripheral light). Peripheral light causes viewer pupillary constriction which adversely affects evaluation of the radiograph and the structures radiographed (Figure 4.57). Magnification of the image is an essential aid to accurate interpretation (Figure 4.58).

Systematic examination of the crown, root/s, pulp chamber/canals, periodontal ligament space and periapical region is imperative. Discontinuity of

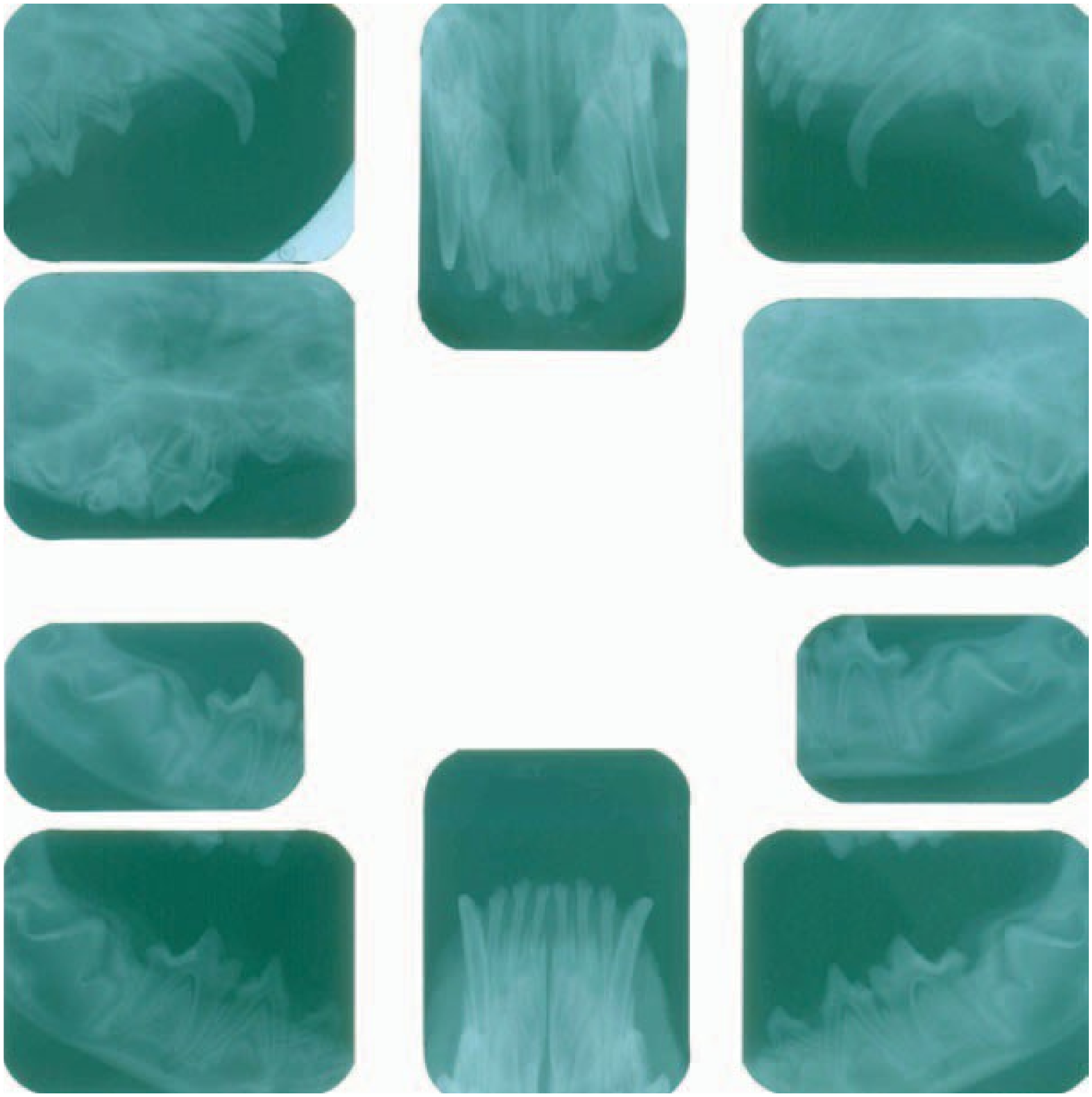


Figure 4.56 An incomplete set of radiographs of a young puppy mounted using the buccal-view mounting configuration.

Figure 4.57 Dental radiographs should be viewed with light passing through the film only, as peripheral light will affect evaluation. This light box is not ideal.

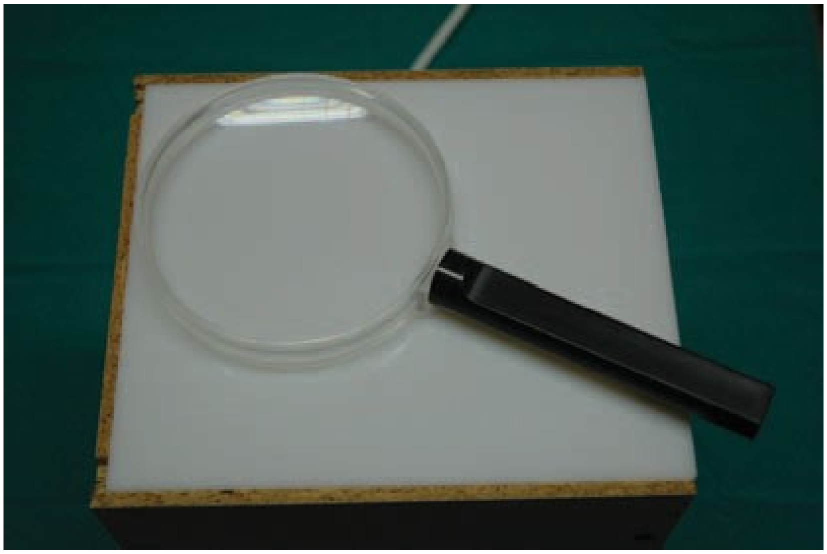


Figure 4.58 Magnified viewing of dental radiographs is mandatory. Substantially more detail is visible using magnification.

Figure 4.59 The teeth must be examined systematically evaluating the crown, root/s, periodontal ligament space, lamina dura, the pulp cavity and root canal. Periapical tissues must be examined as well.

the lamina dura and widening of the periodontal ligament space are indicative of disease and should alert the examiner to investigate further. It may be necessary to take a second or third view of a structure to gain further information (Figure 4.59).

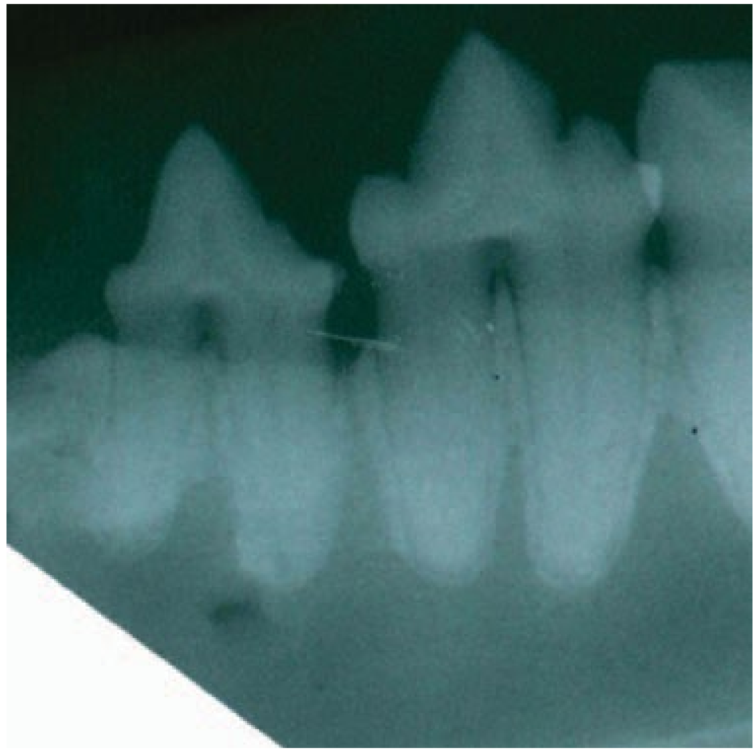


Figure 4.60 A slightly oblique view of the caudal mental foramen close to the distal root apex of mandibular left premolar 3 in a cat.

Figure 4.61 The caudal mental foramen can resemble pathology at the distal root of the mandibular third premolar in the cat.

There are numerous artefacts to consider when viewing radiographs. The mental foramina are positioned at the mandibular third and second premolars and between the first and second incisor teeth in the dog. The middle mental foramen is often mistaken for a periapical radiolucency at the mesial root of the second premolar (Figures 4.60 and 4.61).

Figure 4.62 The infra-orbital canal and maxillary recess can resemble periapical lesions when superimposed on maxillary premolar roots. There are three root fragments remaining in this dog's maxillus after incomplete extraction of 108.

The infra-orbital foramen may create artefacts at the maxillary third or fourth premolars. (Figure 4.62). The maxillary recess may also appear as a radiolucency. There is no maxillary sinus in the dog or cat.

Normal radiographic anatomy

In young animals the pulp chamber and canal are wide and the root apex is unformed (Figures 4.63 and 4.64). The dentine formed at this point is known as primary dentine. As the tooth matures, the apex forms and an apical delta develops through which the pulp receives its neurovascular supply (Figure 4.65). The dentine formed after this time is known as secondary dentine. Primary and secondary dentine are indistinguishable radiographically. Radiographs should be taken of the jaws of young animals where there is suspicion that some teeth may be missing. Amelogenesis is completed at about three to four months of age and the permanent tooth buds will be visible radiographically. It is important to remember that the molars and first premolars do not have deciduous predecessors.

Immature teeth have a wide pulp chamber / canal, relatively narrow (thin) dentine covered by a thin layer of enamel. Mature teeth have pulp chambers / canals of variable width and dentinal walls of variable thickness (depending upon the animal's age) and an apical delta. The periodontal ligament space is visible and defined by the lamina dura on one side and the cementum covering

Figure 4.63 Immature teeth have 'open' roots.

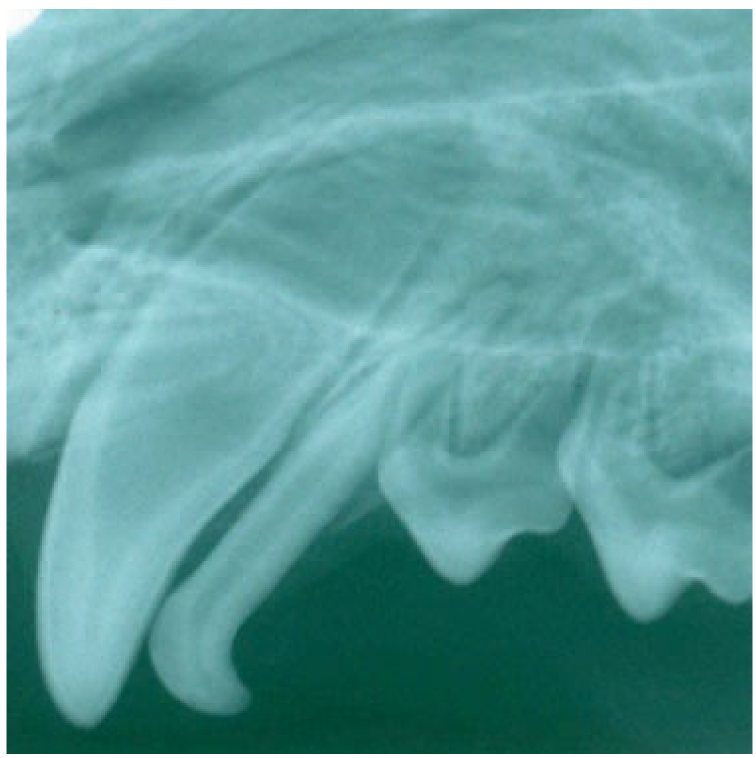


Figure 4.64 The pulp chamber of immature teeth is wide and the dentine walls thin. Note the persistent 604 in this image.

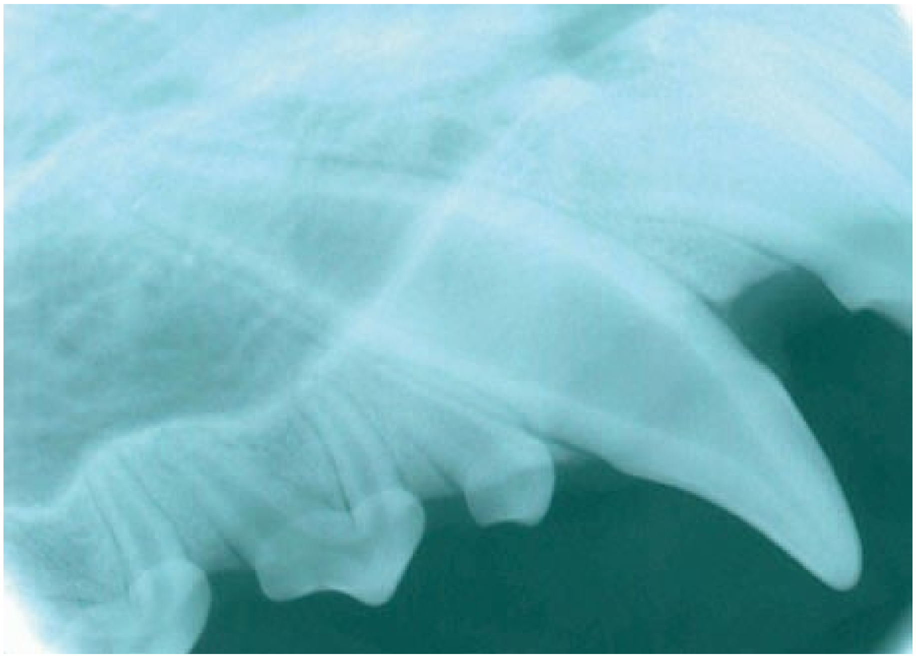


Figure 4.65 Once the apex has formed the tooth is considered to be mature. Normal dentine laid down beyond this stage is classed as secondary dentine.

the root on the other. The lamina dura is the cribriform plate of the alveolus and appears denser than the surrounding bone because it is seen *en face* (end on) (Figures 4.66 and 4.67). The periodontal space houses the periodontal ligament which spans from the cementum to the lamina dura ensuring that the

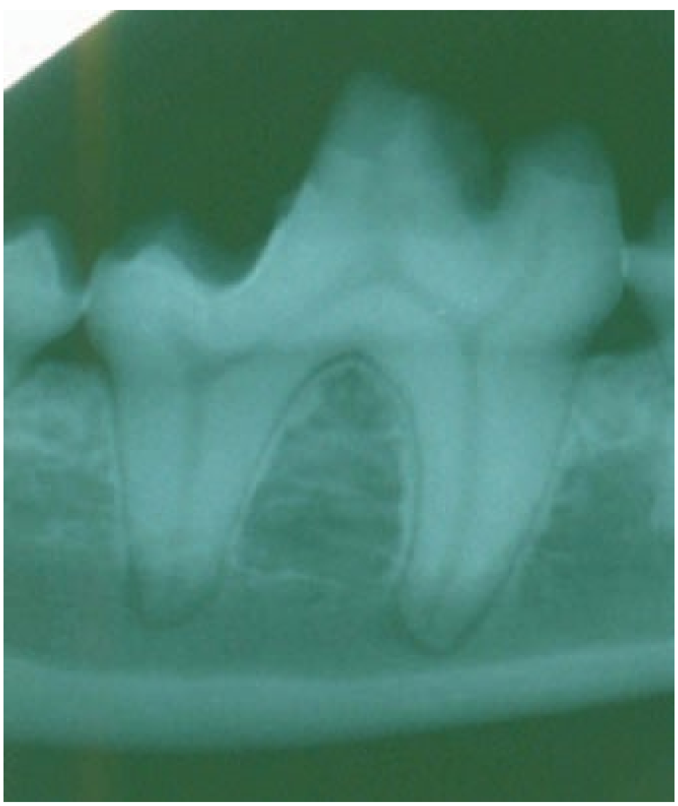


Figure 4.66 The lamina dura of teeth is seen as a radiodense line following the outline of the root.

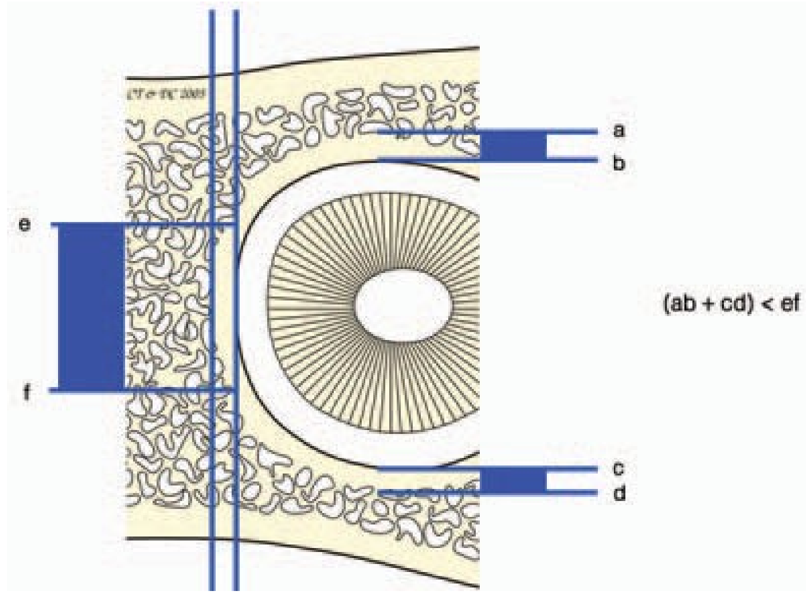


Figure 4.67 The lamina dura appears more radiodense than the surrounding alveolar bone as a result of it being seen *en face*. This is illustrated by the blue lines.

tooth is 'suspended' in the alveolus. The lamina dura is continuous around the root. The apical periodontal space is slightly enlarged at canine apices and the apices of mesial roots of mandibular first molars. It is important to remember that the radiographic image is a two-dimensional representation of a three-dimensional structure.

Under normal circumstances the periodontal ligament and cementum prevent normal bone turnover from affecting the dentition. The periodontal space becomes obliterated in cases undergoing root replacement following resorption. The tooth substance becomes continuous with the surrounding alveolar bone and the tooth is then ankylosed to the bone. Localised inflammation of the periodontal ligament can also lead to ankylosis of the tooth to the alveolus when normal bone turnover crosses the periodontal ligament space.

The mesial root of the mandibular carnassial and the distal root of the maxillary carnassial teeth often have a parallel line visible radiographically at their distal and mesial aspects respectively, due to the developmental groove in the surfaces of these roots (Figures 4.68 and 4.69).

Common abnormalities encountered

Periapical pathology is often characterised by circular radiolucencies surrounding the apex of an affected tooth (usually around all apices of multi-rooted teeth (Figures 4.70 and 4.71)). This is due to bone loss associated with pulpitis. Although the most common cause of periapical pathology is tooth fractures, radiolucencies are periodically seen affecting teeth which are intact and otherwise appear healthy. Pulpitis and pulp necrosis as a result of trauma or haematogenous infection (anachoresis) will also cause periapical bone loss to occur. Widening of the periodontal space and discontinuity of the lamina dura are indications of periodontal pathology. In some animals with severe periodontitis, pockets may become so extensive that the pulp becomes affected (either via lateral or accessory canals or via the apical delta). These lesions are termed periodontic-endodontic (perio-endo) lesions. These lesions are associated with deep, wide periodontal pockets. Conversely endodontic-

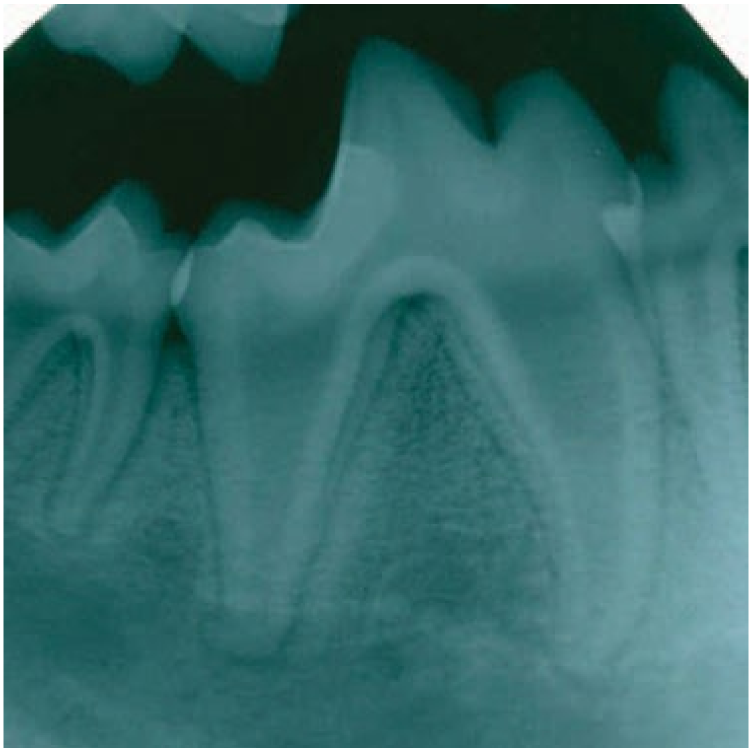


Figure 4.68 Developmental grooves in the mesial part of the distal and distal part of the mesial roots of mandibular carnassial teeth are often seen as parallel lines in these areas.

Figure 4.69 The developmental groove in the distal aspect of this mesial root of the mandibular left carnassial tooth which adds to the anti-rotational stability of the tooth. Note the dilacerated root tip.

periodontic (endo-perio) lesions are as a result of pulp necrosis causing periapical pathology which extends coronally via the periodontal space to involve the marginal periodontium. These lesions are usually associated with deep, narrow periodontal pockets.

Figure 4.70 Multi-rooted teeth usually have periapical pathology affecting the apices of all roots as a result of pulp necrosis. The more lucent area at the apex of the mesial root of this carnassial coincides with a bony defect in the mandible through which a sinus tract communicated with the buccal cavity.

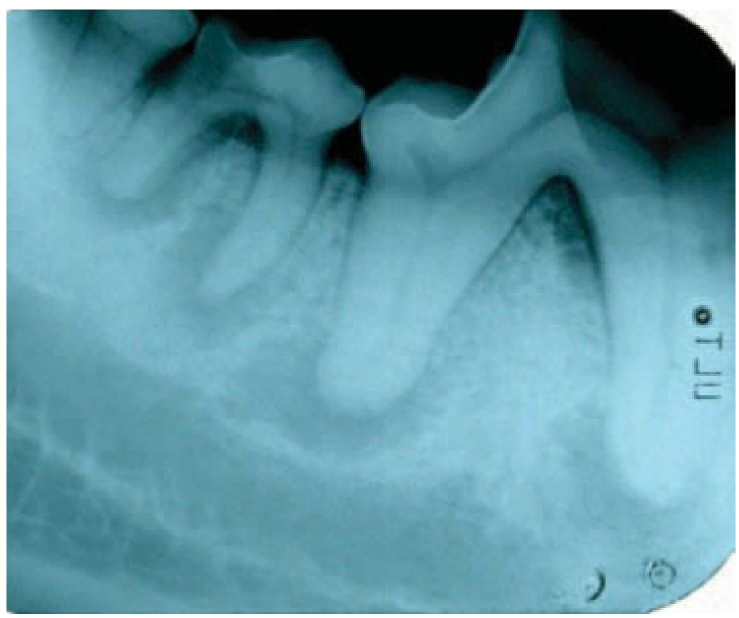


Figure 4.71 Both molars 1 and 2 had complicated crown fractures which were treated using the 'wait and see what happens' method. The patient had stopped eating on this side and showed marked improvement in habitus following extraction of these teeth.

Supernumerary roots are most commonly seen on the maxillary third premolars of dogs (Figures 4.72 and 4.73) and the maxillary second and third premolars in cats.

Fused roots (resembling a peg) may be seen on the mandibular second molar of dogs (Figure 4.74) and mandibular premolars 2 and 3.

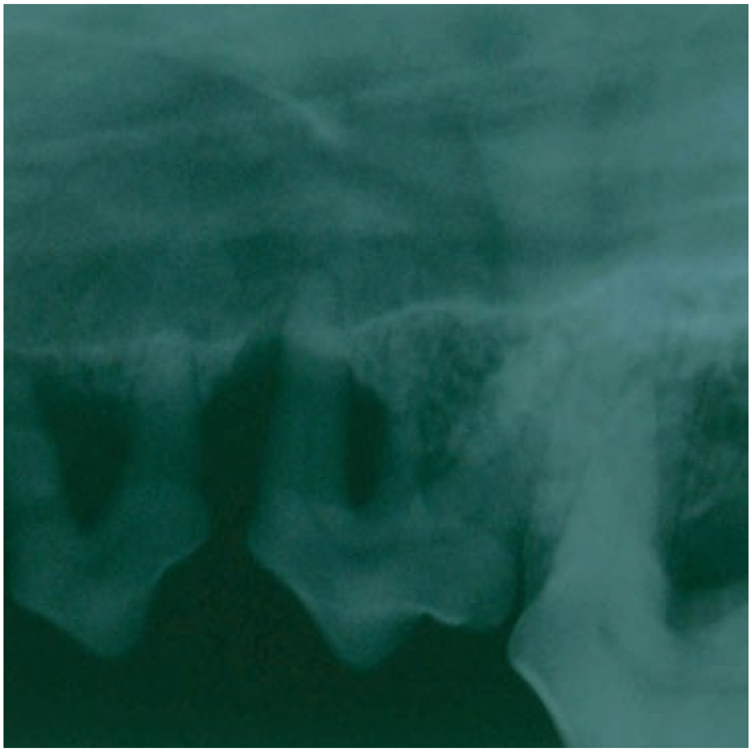


Figure 4.72 This maxillary left premolar 3 had a supernumerary root which had a small palatal cusp suggesting its presence. The root is invisible on this radiograph.

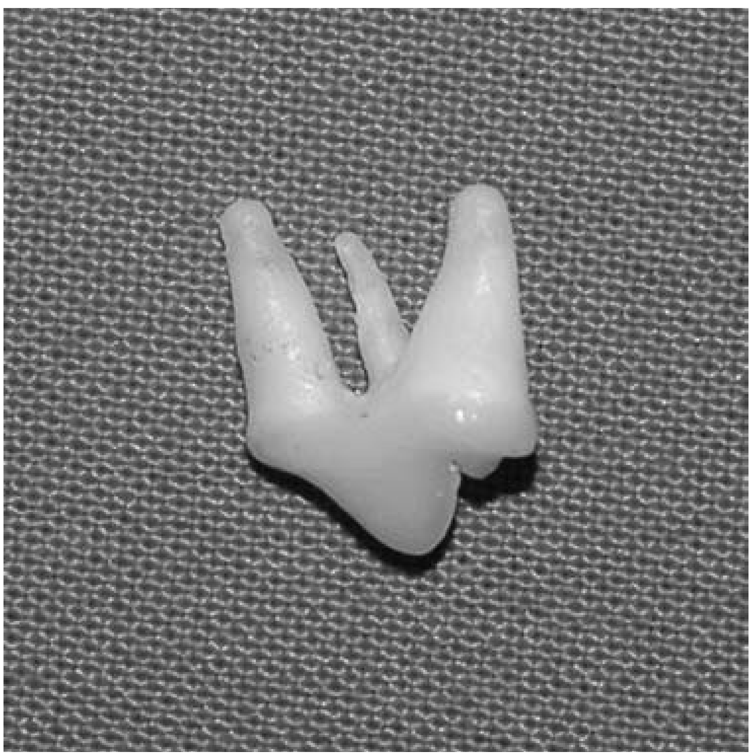


Figure 4.73 The extracted tooth in Figure 4.72. For photographic purposes this tooth was not sectioned and patience was required to luxate it undamaged.

Dilacerated (abruptly bent) roots are sometimes seen on radiographs and the extraction of these teeth can be challenging (Figures 4.75 and 4.76).

Unerupted teeth or teeth affected by impaction (physical obstruction to eruption) are often seen on radiographs taken of clinically edentulous (toothless) parts of the jaw (Figures 4.77 and 4.78).

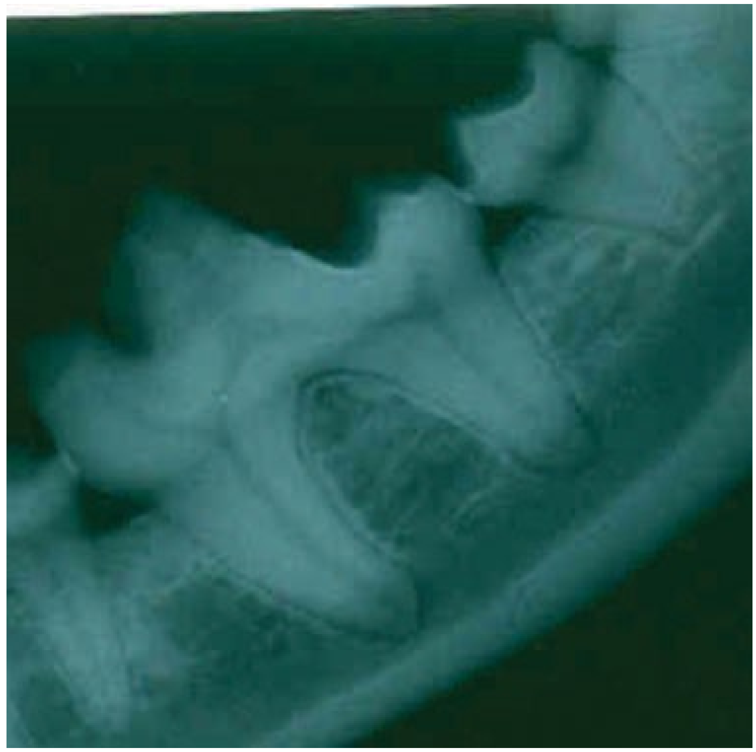


Figure 4.74 The mandibular left molar 2 has fused roots making simple extraction the technique of choice if the tooth were to be extracted. Sectioning multi-rooted teeth blindly can lead to fracture and retention of root remnants if the roots happen to be fused.

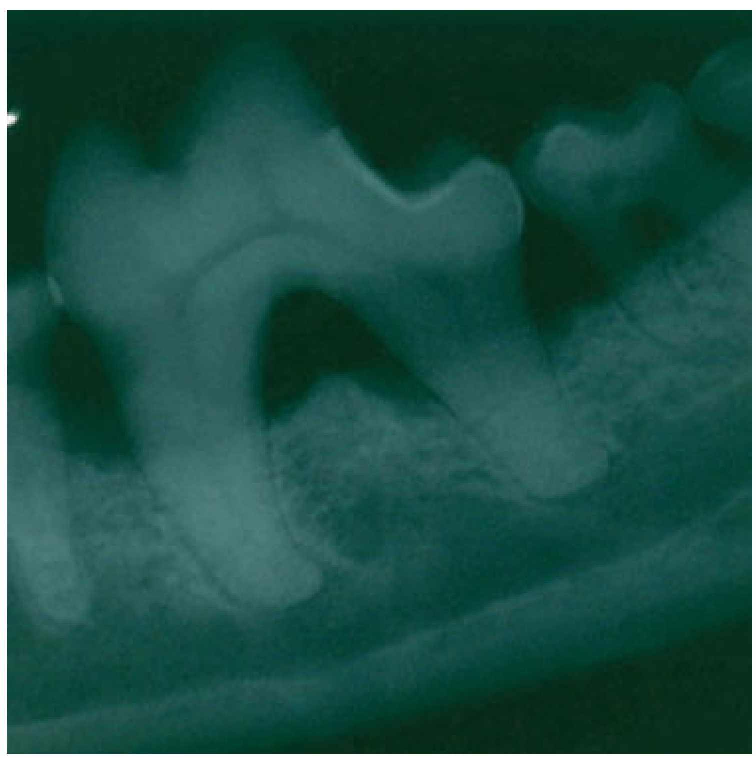


Figure 4.75 Dilacerated roots (roots with angular deformities) can make extraction challenging.

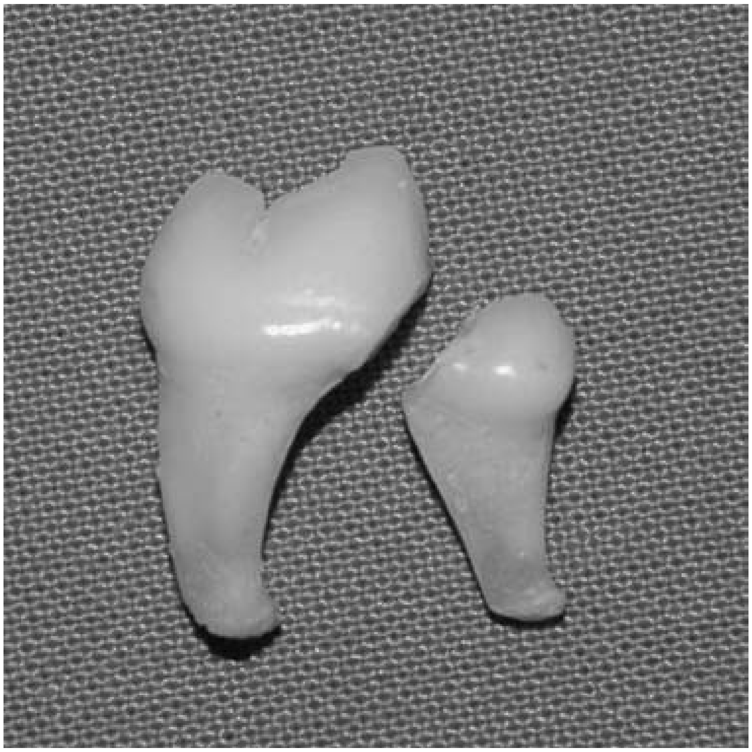


Figure 4.76 The tooth in Figure 4.75 showing the angular deformities affecting both apices.

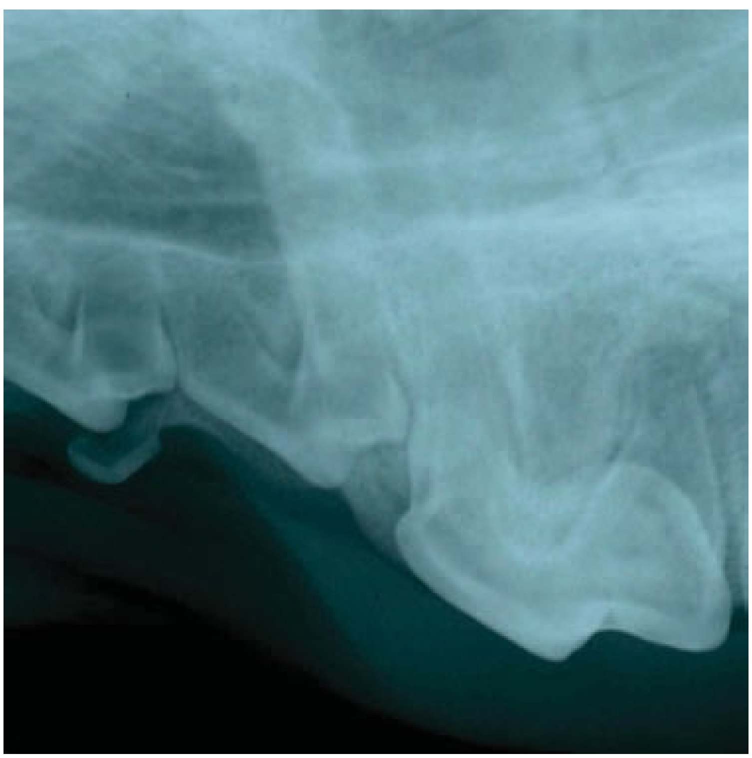


Figure 4.77 The immature maxillary left premolar 3 is impacted against the neck of the carnassial tooth preventing its eruption into the mouth.

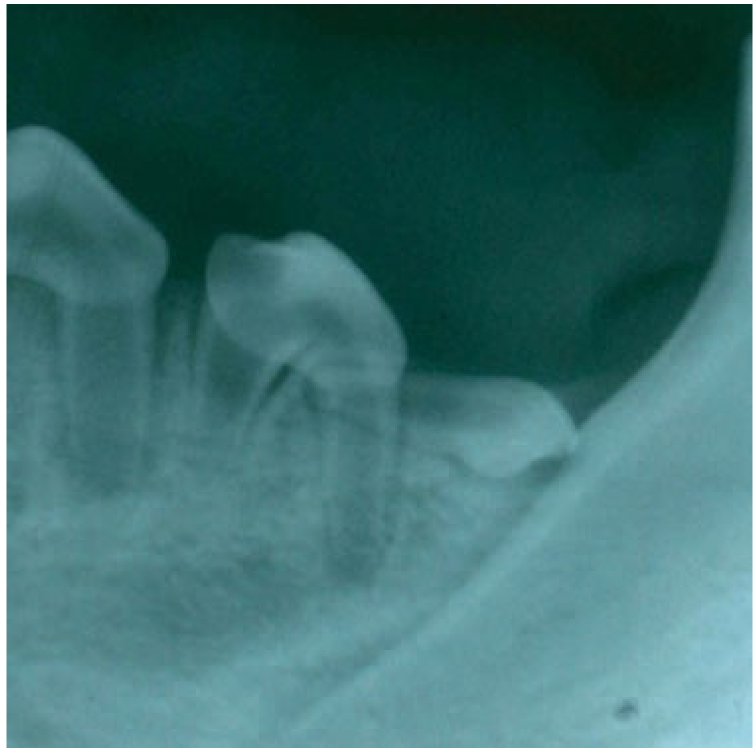


Figure 4.78 The mandibular right premolar 1 has developed parallel to the alveolar margin and will not erupt. The tooth and its left mandibular counterpart were extracted to prevent cystic changes often associated with these teeth when they do not erupt into the mouth.

Some artefacts seen on radiographs (Figures 4.79–4.83)

- scratches prior to and during processing
- finger prints
- film damage due to placement of hanging clips
- grid pattern on radiograph exposed from the back (through lead backing sheet)
- foggy radiograph due to light exposure during processing
- patchy radiograph due to package paper which may have been attached to film during processing
- crystalline material on radiograph due to insufficient rinsing following processing
- grey / blue area on newly processed film due to underfixing.

Radiograph storage

Radiographs must be stored in such a way that they can be retrieved easily for future evaluation and comparison. This should be in a cool and dark, dry place and the radiographs should be rinsed and dried thoroughly only once. The radiographs make up part of the patient record and must therefore be labelled accordingly. Label the mounting card or storage envelope as there is insufficient space on the radiographs to enter patient and client details. When using medical X-ray film it is essential to mark left and right arcades using radiopaque markers. Intra-oral film has a raised dot near one corner enabling orientation.

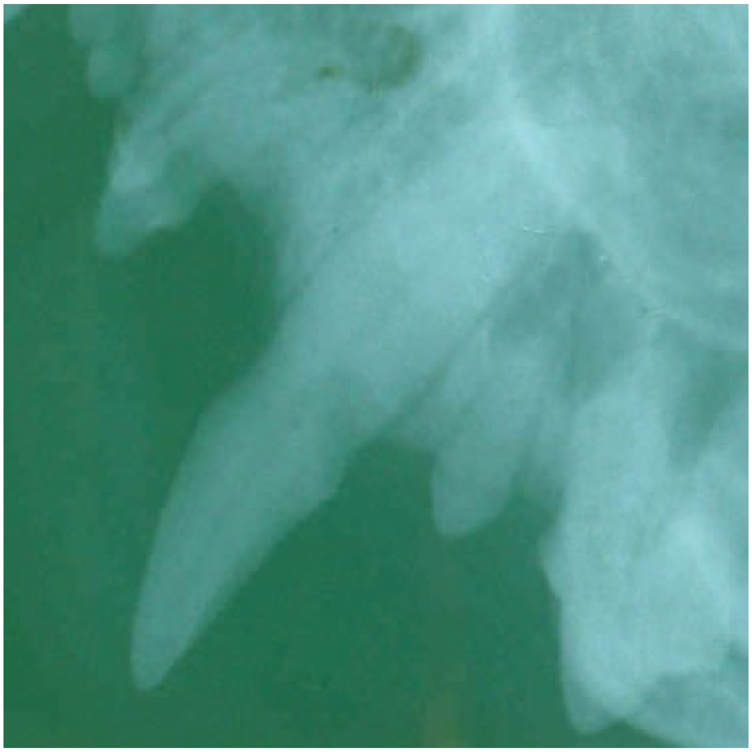


Figure 4.79 This radiograph is discoloured brown as a result of insufficient rinsing following processing.

Figure 4.80 This radiograph has elongated incisors and canines superimposed on premolars making it of little diagnostic value.

Figure 4.81 There are scratches on this radiograph which interfere with interpretation.

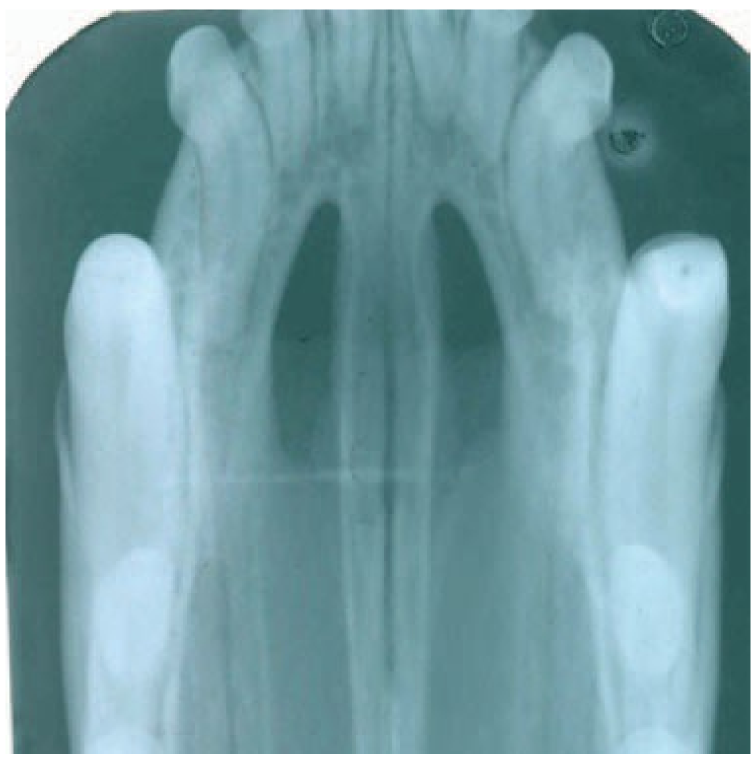


Figure 4.82 The incisors are ‘coned off’ and the canines superimposed on the premolars leading to a radiograph of no diagnostic value.

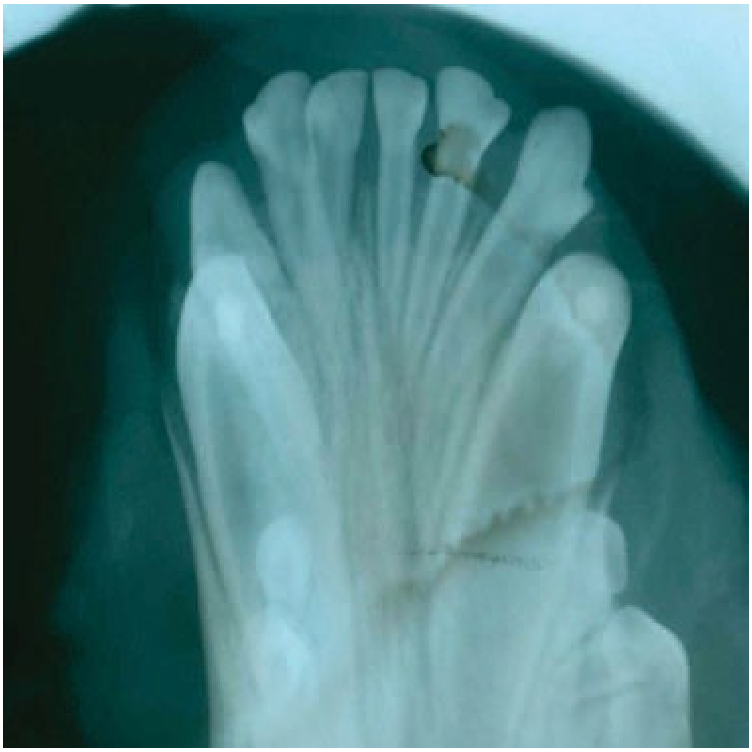


Figure 4.83 Processing chemical residues have discoloured this radiograph.

Processing chemicals

Processing chemicals may pose a health hazard and must be handled using appropriate protective wear. The chemicals must be disposed of according to health and safety regulations and must under no circumstances be poured down the drain.

Further reading

Crossley, D.A. and Penman, S. (Eds) (1995) *Manual of Small Animal Dentistry*. BSAVA Publications, Cheltenham, UK.

Holstrom, S.E., Frost, P. and Eisner, E.R. (1998) *Veterinary Dental Techniques for the Small Animal Practitioner* (2nd edn). W.B. Saunders Company, Philadelphia.

Mulligan, T.W., Aller, M.S. and Williams, C.A. (1998) *Atlas of Canine and Feline Dental Radiography*. Veterinary Learning Systems, New Jersey.

Wiggs, R.B. and Lobprise, H.B. (1997) *Veterinary Dentistry Principles and Practice*. Lippincott–Raven, Philadelphia.

5 Exodontics

Tooth extraction is final. In selected cases teeth can be replaced using implants however for most pet owners this procedure is cost prohibitive.

Adequate analgesia must be given to patients about to undergo tooth extraction (see Chapter 11 – Pain Management.)

Indications for tooth extraction

- fractured teeth which cannot be restored
- teeth affected by caries (lesions so severe that restoration is not possible)
- persistent deciduous teeth
- supernumerary teeth causing crowding
- maloccluding teeth
- teeth in a jaw fracture line (which are not providing fixation stability)
- periodontally compromised teeth
- severe chronic gingivo-stomatitis
- malformed teeth causing gingivitis and periodontal disease
- luxated or subluxated teeth (including intruded teeth) not amenable to treatment
- retained (unerupted) teeth
- teeth affected by odontoclastic resorption

Figures 5.1–5.22 are a series of indications for extraction.

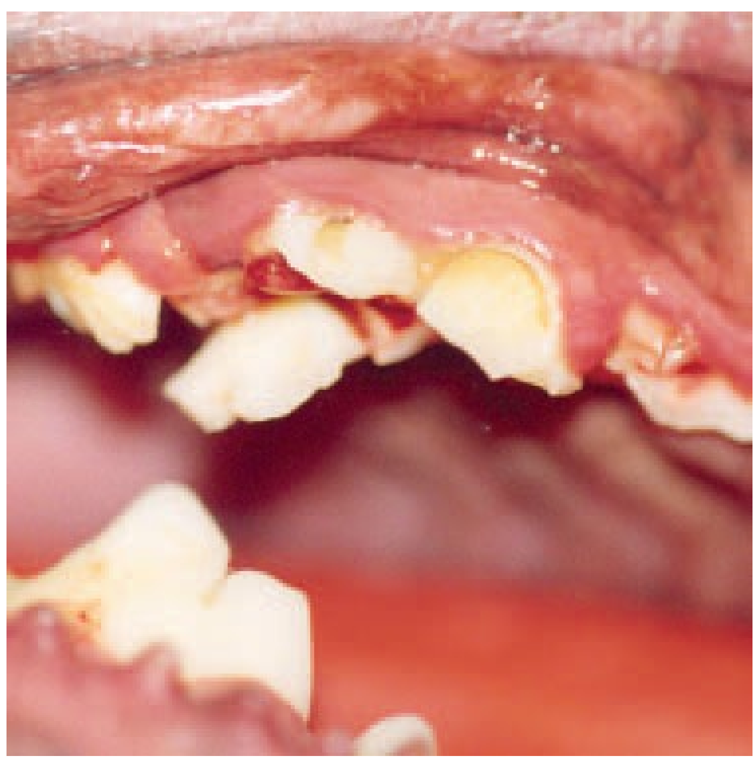


Figure 5.1 This patient was kicked in the mouth by a horse and suffered multiple fractures of its teeth.

Figure 5.2 The lateral incisor was damaged and the middle incisor is missing in this patient. There was no history of trauma but these injuries must have occurred before the animal was three months of age judging by the enamel defects on the canine.

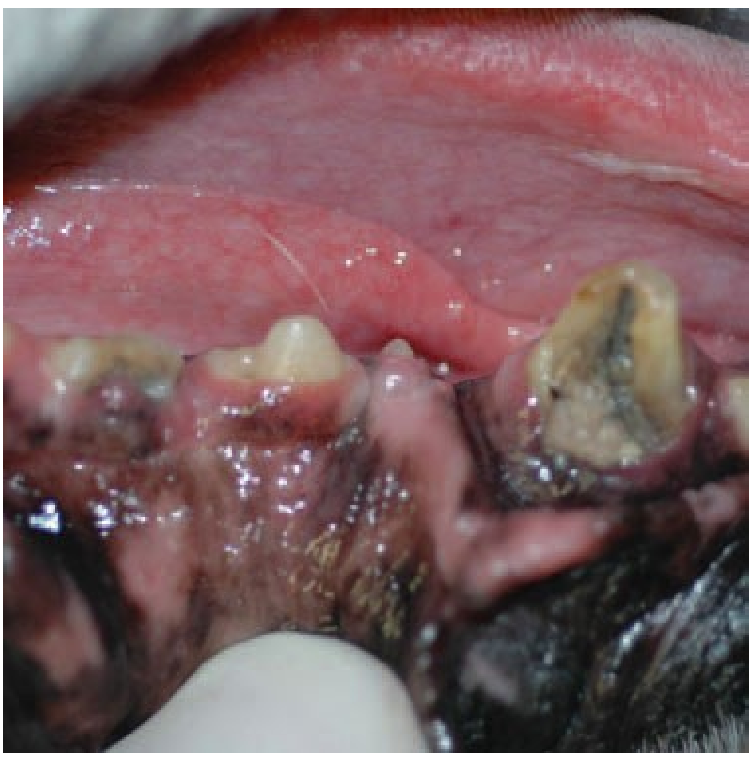


Figure 5.3 The mandibular right canine and third premolar are fractured with chronic pulp exposure. Restoration and root canal therapy is contraindicated in these teeth, where the fractures extend sub-gingivally.

Figure 5.4 This mandibular carnassial tooth had a slab fracture extending sub-gingivally. The periodontal probe indicates a probing depth in excess of about 12 mm (this probe is graduated to 15 mm).

Figure 5.5 Persistent deciduous canine teeth should be extracted before they compromise the permanent dentition as they have in this case.

Figure 5.6 These incisors are crowded and there is a persistent mandibular left deciduous lateral incisor. Radiography should be performed prior to extraction to determine the proximity of the deciduous tooth root to the permanent dentition and to confirm that the root is still present.

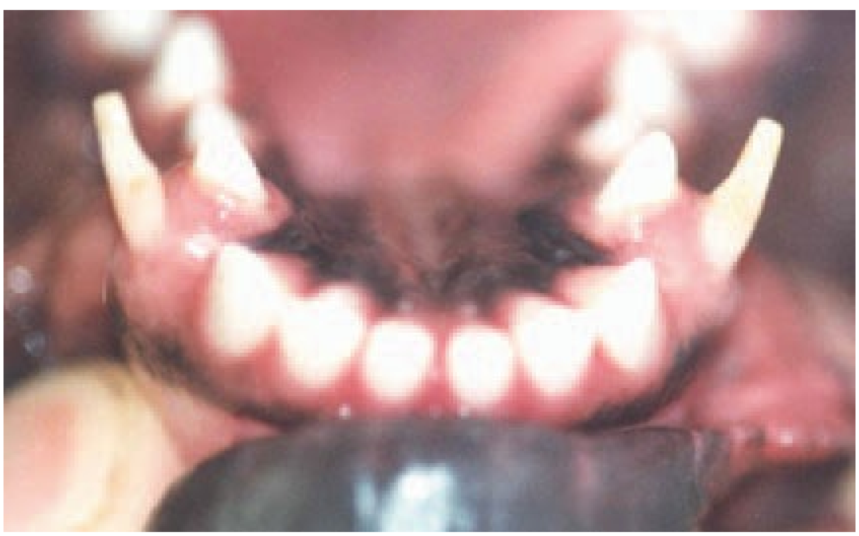


Figure 5.7 These persistent deciduous canines should be extracted to create space into which the permanent canines can move. Failing to do this will result in the permanent canines becoming remaining linguo-verted.

Figure 5.8 The pulp cavities of the maxillary left and right lateral incisors are exposed as a result of chronic abrasian.

Figure 5.9 The maxillary right lateral incisor has undergone abrasion mesially and attrition distally and the mandibular right canine has undergone attrition mesially. Abrasion is due to wear against a foreign object while attrition is wear from tooth-on-tooth contact.

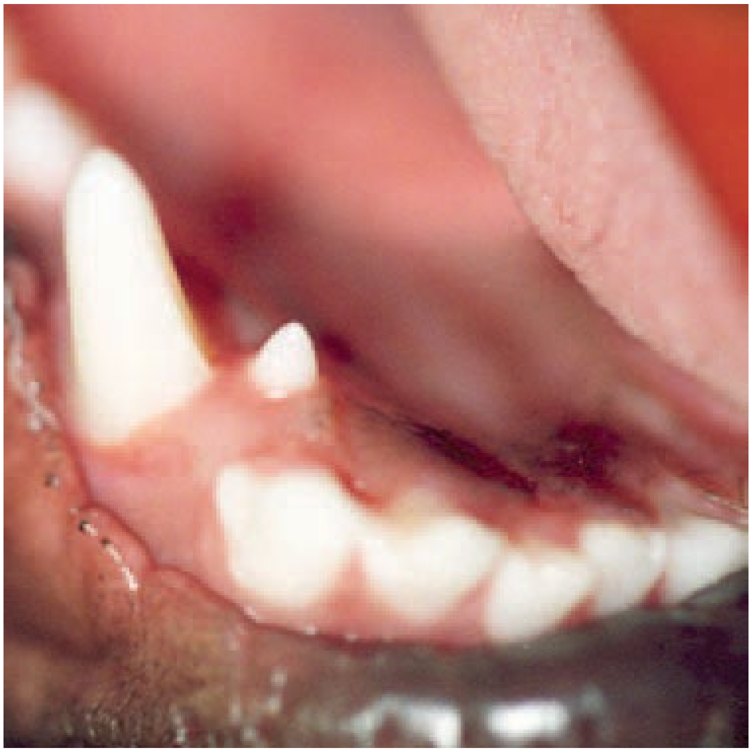


Figure 5.10 Supernumerary teeth should be extracted if they cause crowding or compromisation of the adult dentition.

Figure 5.11 The 'peg tooth' in Figure 5.10. Note the severely dilacerated root.

Figure 5.12 Periodontally compromised teeth should be extracted.

Figure 5.13 This mandibular left molar 1 has no bony support around the distal root. An alternative to complete extraction is hemisection and extraction of the distal crown-root fragment, and root canal therapy on the mesial crown-root fragment.

Figure 5.14 Teeth with Grade 3 furcation lesions should be extracted unless the client can keep the area clean using inter-dental brushes.

Figure 5.15 A draining sinus on the cheek or face is often an indication of periapical pathology.

Figure 5.16 Purulent exudate was found at the apex of this canine tooth (patient in Figure 5.15) even though the crown was intact. Haematogenous infection (anachoresis) of the root and pulp is the most likely cause.

Figure 5.17 Odontoclastic resorption is treated by extraction of the affected tooth. Note the gingiva attached to the linguo-occlusal surface of the distal cusp of this mandibular right carnassial in a dog.

Figure 5.18 Teeth affected by Stage 5b feline odontoclastic resorptive lesions (FORL) (mandibular right canine) are treated by raising an envelope gingival flap, crown amputation and flap closure.

Figure 5.19 The mandibular right premolar 3 has a Stage 3 FORL. Although part of the root has been resorbed and replaced by bone, there is still some root substance remaining and this should be extracted.

Figure 5.20 A supernumerary mandibular left premolar 4 has lead to crowding and compromisation of these teeth. The affected teeth should be extracted.

Figure 5.21 Deep pockets between teeth are an indication of severe bone loss. Open curettage and flap closure or attempts at guided tissue regeneration may be undertaken but these teeth are usually extracted. Note the mucosal lesion (just below the gloved finger) as a result of plaque at the periodontal lesion.

Figure 5.22 Teeth associated with oral tumours are most commonly extracted.

Equipment required

Scalpel blade (15 or 15C) and handle, periosteal elevator, high-or slow-speed handpiece and burs for sectioning teeth and alveoloplasty, dental luxation instruments and elevators, fine rat-toothed forceps, material and surgical scissors, needle holder and monofilament absorbable suture material (Figure 5.23).

Planning

Once the diagnosis of dental disease requiring tooth extraction has been made, the procedure must be well planned to prevent subsequent problems. For example, the alveolar buccal bulge of the maxillary canine keeps the upper lip out of the path of the mandibular canine when the mouth is being closed. Occasionally when maxillary canines are extracted and the alveolar buccal bulge is removed the mandibular canine will trap the upper lip resulting in formation of an eosinophilic granuloma or ulcer in cats. This condition is treated by rounding of the mandibular canine tip, crown shortening and sometimes root canal therapy or extraction of the offending tooth. Maintaining the maxillary canine buccal alveolar bulge will prevent this.

Pre-operative radiographs of the affected teeth are essential, enabling visualisation of the shape, length and presence of roots. If the roots have been completely resorbed and replaced by bone there is no need to create a large flap and remove buccal alveolar bone in order to extract non-existent roots. In these cases the treatment of choice is an envelope flap (Figure 5.24) raised to expose the neck of the tooth, followed by crown amputation and reduction of

Figure 5.23 A surgical extraction kit should comprise: periosteal elevator, Adson's tissue forceps, No. 3 scalpel handle, Metzenbaum surgical scissors, material scissors and a needle holder.

Figure 5.24 An envelope flap raised to perform crown amputation extraction technique on a tooth affected by FORL (feline odontoclastic resorptive lesions), the roots of which have undergone replacement resorption.

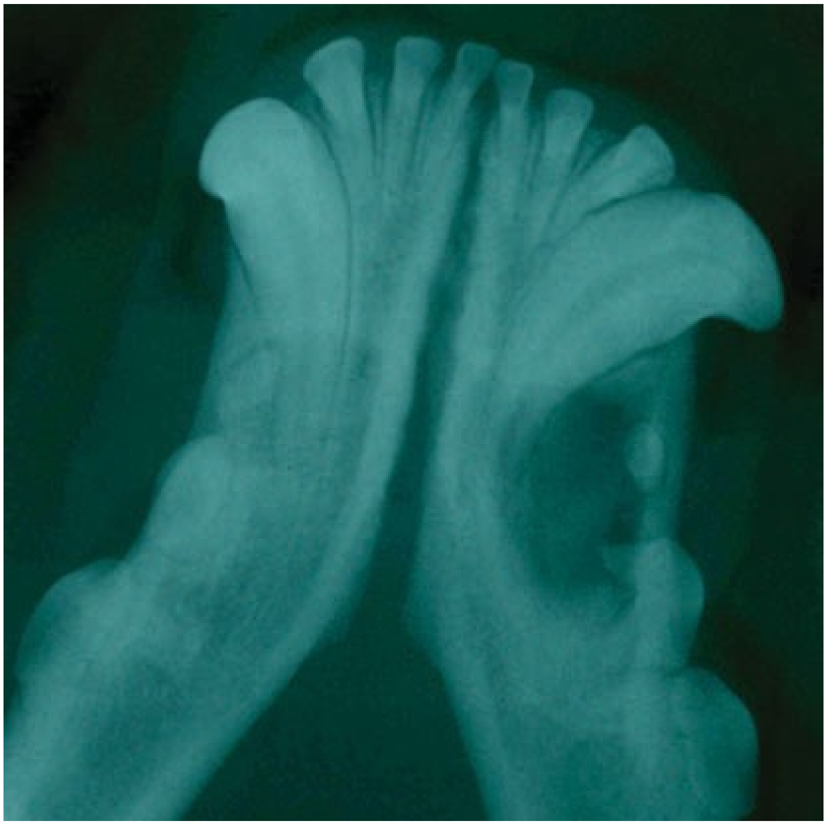


Figure 5.25 A dentigerous cyst associated with an unerupted mandibular left premolar 1 in a Boxer dog.

replacement bone to 1 mm below the alveolar margin, and tension-free closure of the flap. Note: if there are root remnants present, this procedure is not indicated and the root remnants must be extracted.

Some teeth have supernumerary roots and unless this was revealed on a pre-operative radiograph the extra root will not be extracted. This can result in development of a root abscess. Radiographs should also be taken of edentulous (toothless) regions to rule out the presence of root remnants and retained (unerupted) teeth. This is especially important in Boxer dogs which appear to be missing premolar 1 in any quadrant. These teeth are often associated with dentigerous cysts which require surgical excision and extraction of the tooth (Figure 5.25). Failure to excise the cyst and extract the tooth may result in fracture of the affected mandible. The tooth and associated tissues must be submitted for histopathological examination to rule out neoplasia.

Important structures and areas susceptible to injury must be considered when planning extractions and surgical flaps (Figure 5.26).

Teeth may be extracted by one of two procedures, viz. simple (closed) extraction technique or surgical (open) extraction technique.

Generally speaking single-rooted teeth and those multi-rooted teeth which are severely periodontally compromised may be extracted using the simple extraction technique.

The simple (closed) extraction technique

In this technique the tooth is extracted without a surgical flap being raised. A scalpel blade (15 or 15C) is used to sever the gingival attachment by placing

Figure 5.26 Important structures to consider when planning extractions: A = thin alveolar bone labial to incisor teeth; B = a branch of the major palatine artery passes through between the canine and lateral incisor and bleeds profusely when severed (digital pressure effects haemostasis); C = the mental neurovascular bundle exits the mandibular canal at the middle mental foramen; D = the infra-orbital neurovascular structures exit the infra-orbital canal here; E = there is very little alveolar bone distal to the caudal maxillary molar (periodontal disease can destroy all of this bone); F (inset) = the orbit is unprotected caudal to the maxillary second molar; * = the globe!

it in the gingival sulcus / pocket and incising the attachment down to the alveolar bone circumferentially around the neck of the tooth. A sharp luxation instrument can also be used to sever the epithelial attachment (Figures 5.27 and 5.28).

Dental luxation instruments and elevators must be held in such a way that they will not cause damage to soft tissues and adjacent vital organs (eye, neurovascular bundles and the brain) should they slip. The instrument is held in the palm of the hand (Figure 5.29) with the index finger extended along the shaft of the instrument (Figure 5.30 and Figure 5.31). Once the epithelial attachment has been severed, a dental Luxator® is inserted into the sulcus and gently worked apically into the periodontal ligament space (Figures 5.32 and 5.33). The fine tip of the Luxator® will sever the ligament and compress the alveolar bone, creating space for the more robust elevator to be inserted. Begin by working on the lingual aspect of teeth and then progress buccally (Figures 5.34–5.37). Gentle rotational (wrist) movements about the shaft of the Luxator® will aid in destruction of the periodontal ligament in an apical direction. It is often possible to deliver the tooth from its alveolus using a Luxator® (Figure 5.38). Once the tooth has become loosened and the periodontal space enlarged, an elevator can be used to further loosen the tooth and deliver it from the alveolus.

Luxation instruments and elevators should never be used as levers in a manner resembling the opening of a paint can using a screwdriver! (Figure 5.39). All leverage actions applied to elevators are rotational about the shaft of the instrument (Figure 5.40).

When sufficiently loosened, the tooth can either be delivered using the elevator or gently lifted out using dental extraction forceps. A word of advice – do not use dental extraction forceps until you have received training in their

Figure 5.27 Severing the periodontal ligament mesially using a Luxator®.

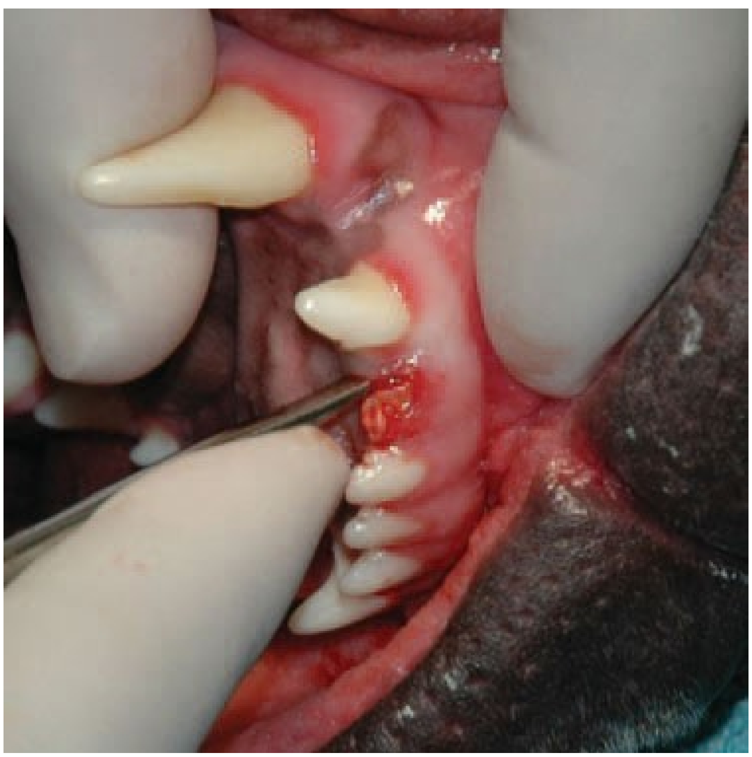


Figure 5.28 Severing the periodontal ligament distally using a Luxator®.

use. Inappropriate use of dental extraction forceps will lead to tooth fracture and increased levels of frustration, as well as prolonging the procedure by having to retrieve root remnants! There are numerous patterns of dental extraction forceps designed for extraction of the differently shaped teeth found

Figure 5.29 Luxation and elevation instruments must be held using the palm grip.

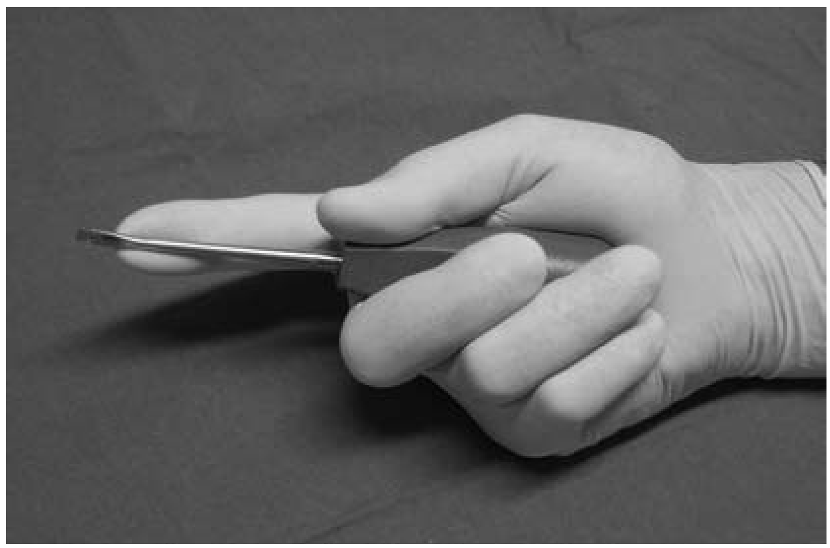


Figure 5.30 The index finger must be extended along the shaft of the Luxator® to protect tissues should it slip off the bone or tooth.

Figure 5.31 An elevator correctly held.

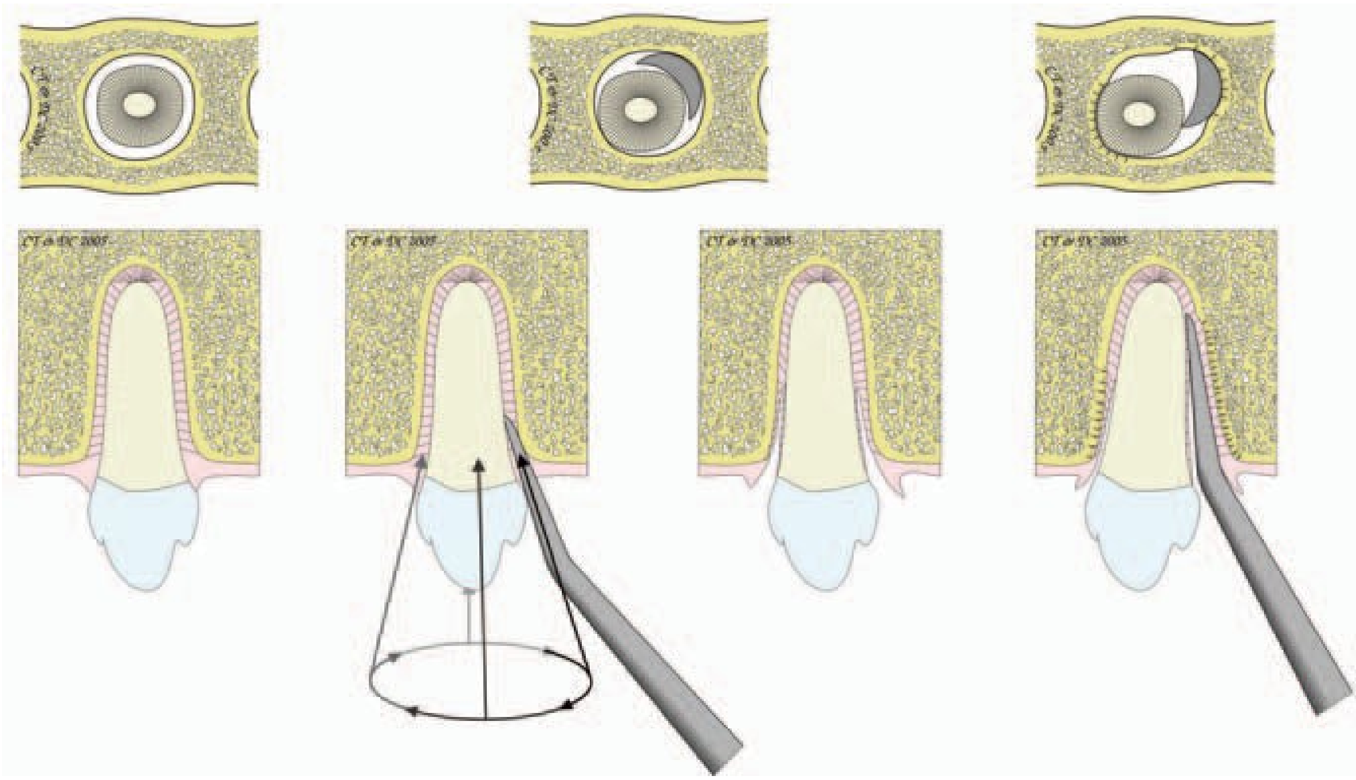


Figure 5.32 The luxation instrument is used to sever the periodontal ligament circumferentially around the tooth.

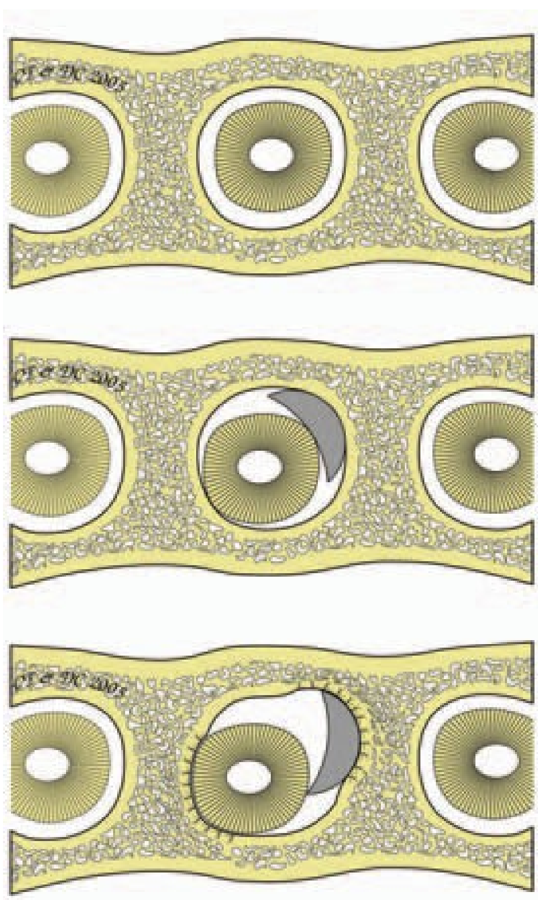


Figure 5.33 The Luxator® creates space for the elevator to fit into by compressing the alveolar bone.

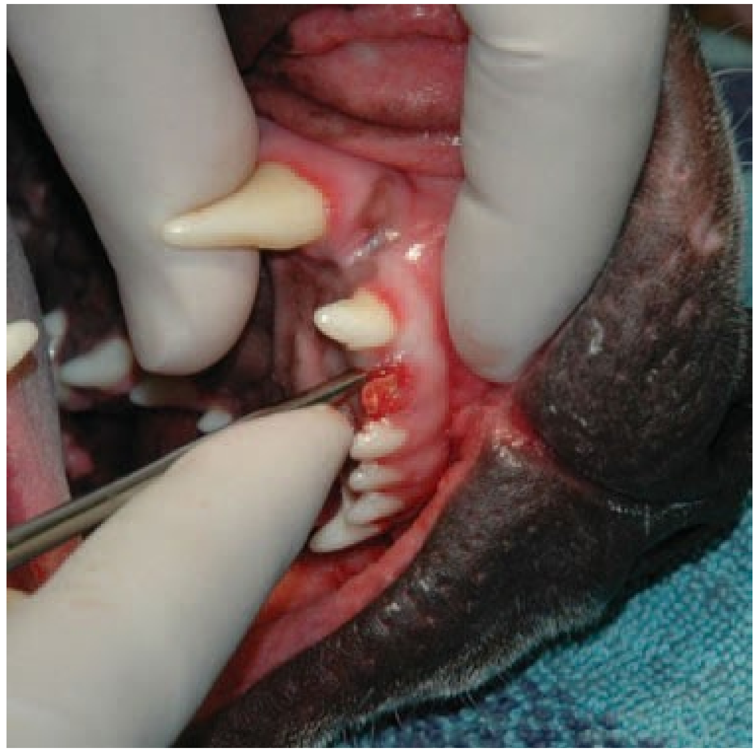


Figure 5.34 Once the ligament is severed circumferentially begin luxating lingually / palatally.

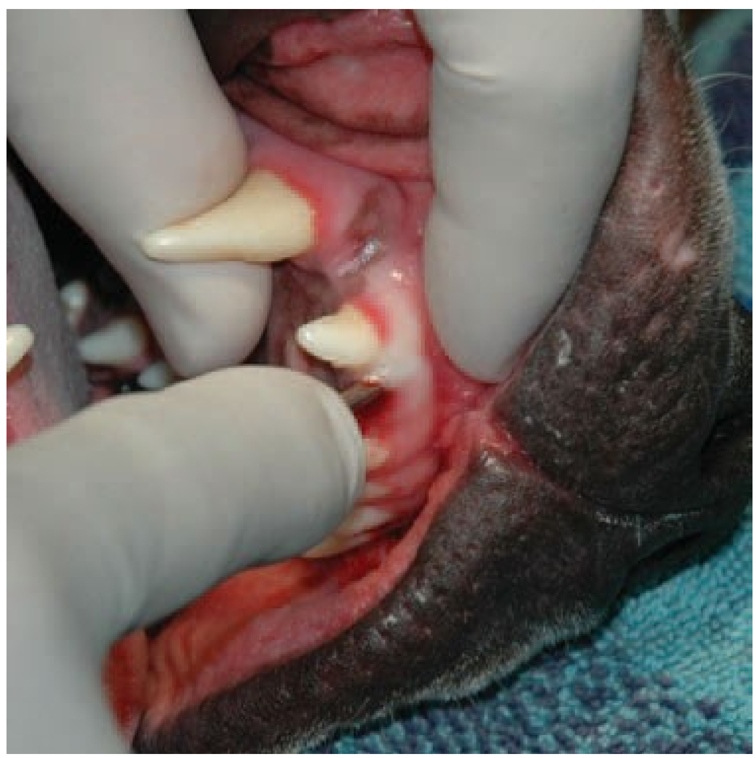


Figure 5.35 Luxating distally.

Figure 5.36 Luxating labially.

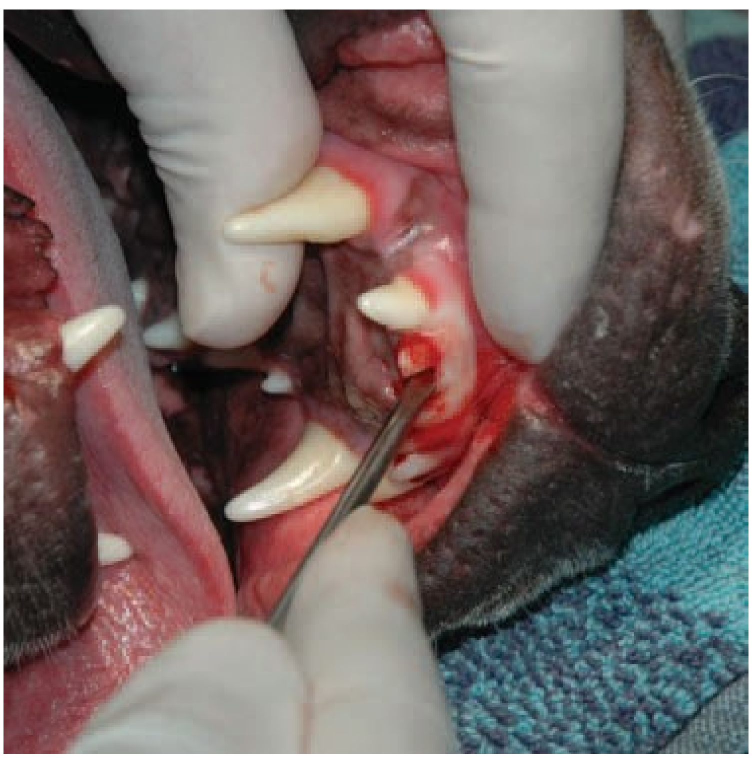


Figure 5.37 Luxating mesially. Note the rotational force applied to the Luxator® moving the tooth away from the alveolar wall.

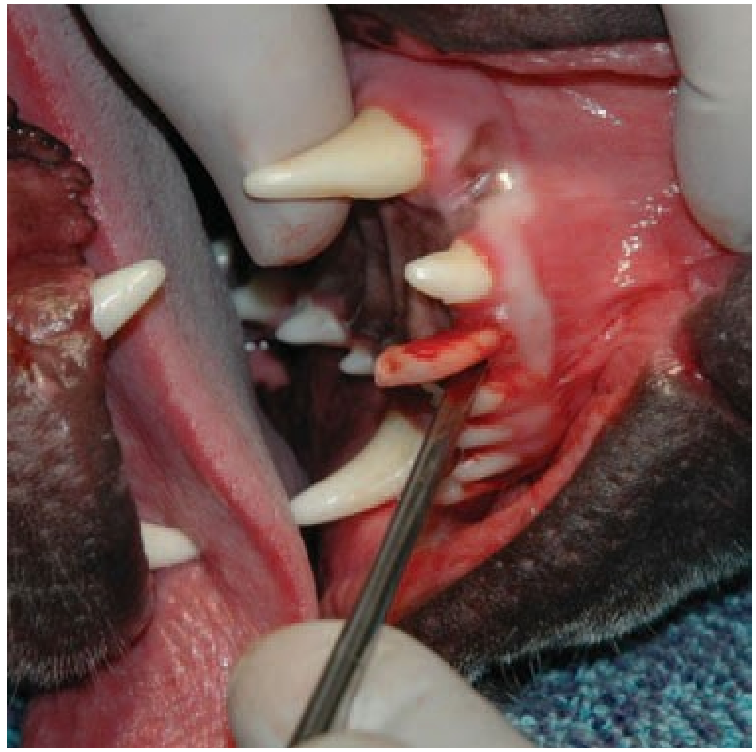


Figure 5.38 Using a Luxator® to deliver the tooth.

Figure 5.39 Do not use Luxators® and elevators in the manner in which one would use a screwdriver to lever the lid from a paint can!

in man and most of these are inappropriate for use in domestic animals. When delivering the tooth from the alveolus using forceps, place the beaks of the forceps as far apically as possible ensuring that the extraction forceps beaks fit snugly around the tooth neck or root. Ill-fitting forceps will shatter the tooth.

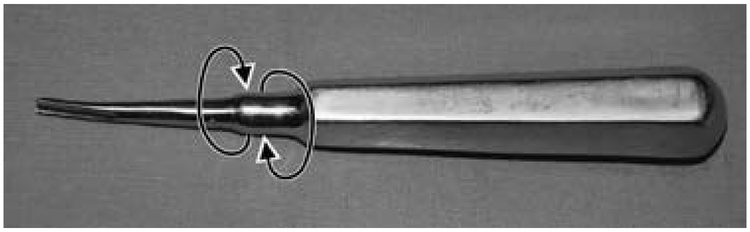


Figure 5.40 Rotational forces should be used to dislodge the tooth.

Figure 5.41 Canines and maxillary lateral incisors have large, strangely shaped roots which can complicate the simple extraction technique and should therefore be extracted surgically.

Following simple extraction the alveolus may be allowed to heal by second intention or an apposing suture may be placed in the gingiva to hold the clot in place, preventing impaction of food and other debris and promoting first intention healing. Suturing is desirable unless the alveolus is infected.

The surgical (open) extraction technique

The surgical extraction technique is used for the extraction of multi-rooted teeth as well as for single-rooted teeth which have unusually shaped or very large roots. The latter include the maxillary lateral incisors and the maxillary and mandibular canines (Figure 5.41).

Extracting single-rooted teeth

When single-rooted teeth are fractured with sub-gingival extension of the fracture line, a surgical approach will provide better visualisation and speed up the extraction process. A mucoperiosteal flap is raised, to facilitate extraction of these teeth (Figure 5.42). If there is tension in the flap (insufficient flap

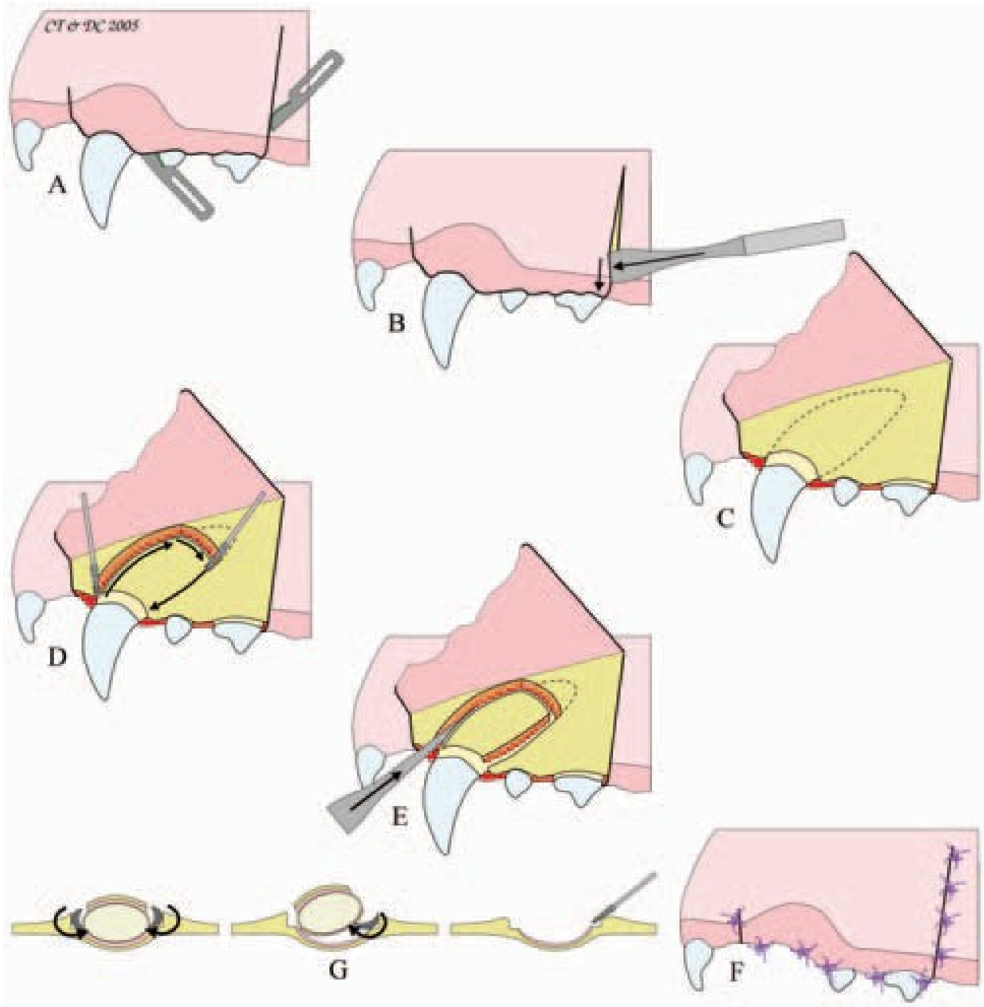


Figure 5.42 Stages in raising and closing a mucoperiosteal flap.
A: A gingival incision is made with releasing incisions mesially and distally. The junction of the gingival and releasing incisions is curved so as not to compromise the 'corner'. The releasing incisions are made perpendicular to the gingival incision to preserve blood supply to the gingiva.
B: A periosteal elevator is used to raise the mucoperiosteal flap from the alveolar bone. This is facilitated by inserting the periosteal elevator under the periosteum apical to the mucogingival line.
C: The flap is raised to expose the juga (bony alveolar bulge covering the root) of the tooth to be extracted.
D: An alveolotomy is performed removing bone to expose the periodontal ligament.
E: A luxation instrument is used to sever the periodontal ligament and dislodge the tooth from its alveolus.
F: The flap is sutured back in place using synthetic monofilament absorbable suture material.
G (from left to right): Luxation and elevation instruments are used to dislodge the tooth from its alveolus. The alveolar bone is used as a fulcrum against which rotational forces are applied. Alveoloplasty is performed prior to flap closure to ensure the flap is not traumatised by sharp alveolar edges.

to close the defect) a releasing incision is made in the periosteum at the base of the flap allowing it to advance and close the defect (Figure 5.43).

Extracting two-rooted teeth

It is often beneficial to amputate the crown of the tooth to be extracted as this facilitates access to the periodontal ligament. This will also prevent fractures

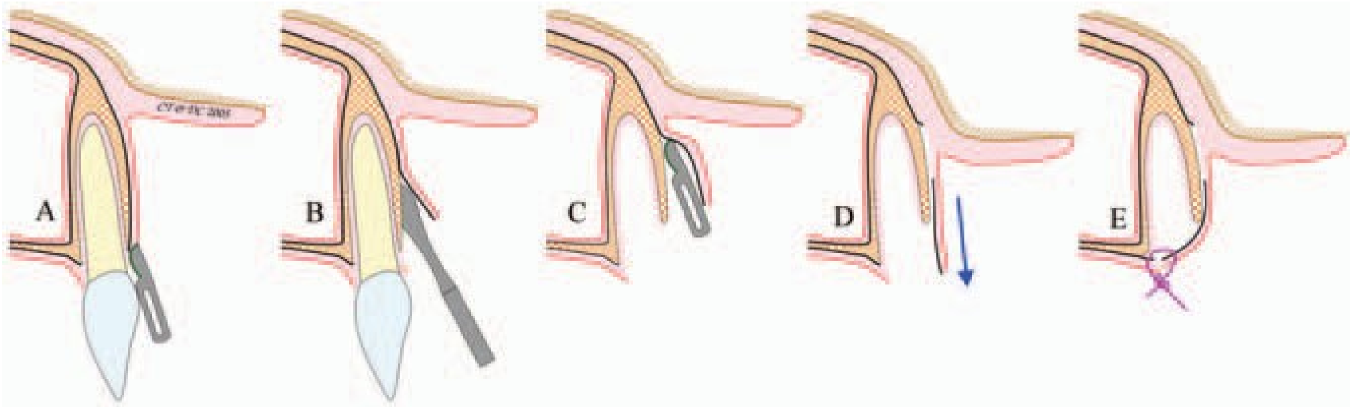


Figure 5.43 If there is tension in the flap, a releasing incision is made in the periosteum at the base of the flap allowing advancement of the flap.
A: The gingiva is incised down to the alveolar margin.
B: The mucoperiosteal flap is raised and the tooth extracted.
C: The periosteum is incised at the base of the flap (apical to the mucogingival line).
D: The flap is advanced.
E: The flap is sutured closed without tension using monofilament absorbable suture material.

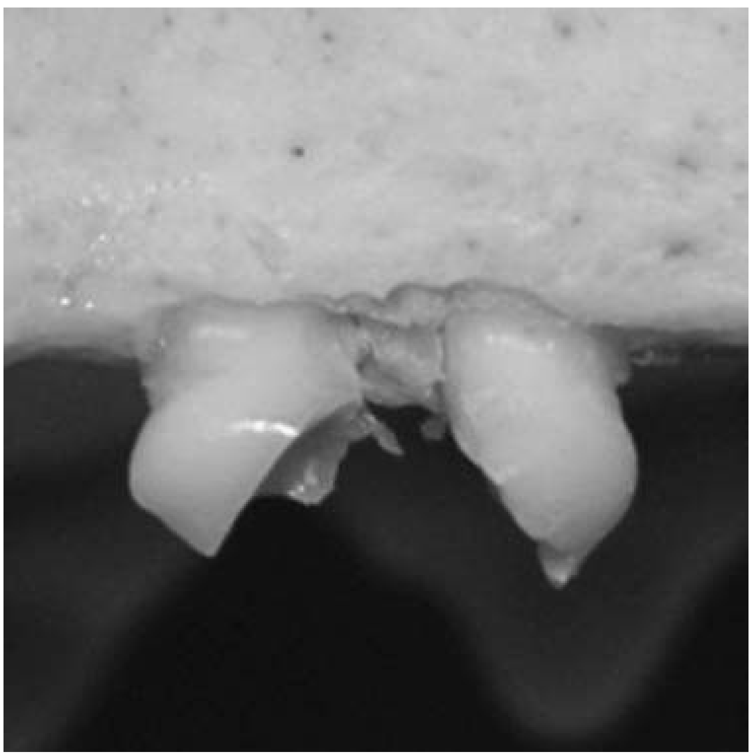


Figure 5.44 A wedge of crown is removed to create better access to the periodontal ligament space.

due to inadvertent leverage against the crown while accessing the periodontal ligament. Another beneficial technique is to excise a wedge from the crown. Beginning at the furcation, the crown is sectioned mesio- and disto-occlusally and the wedge of crown removed (Figure 5.44) to prevent leverage against a tall crown fragment (Figure 5.45) increasing leverage forces which can result in crown and or root fracture. Where teeth are very close together the 'tooth

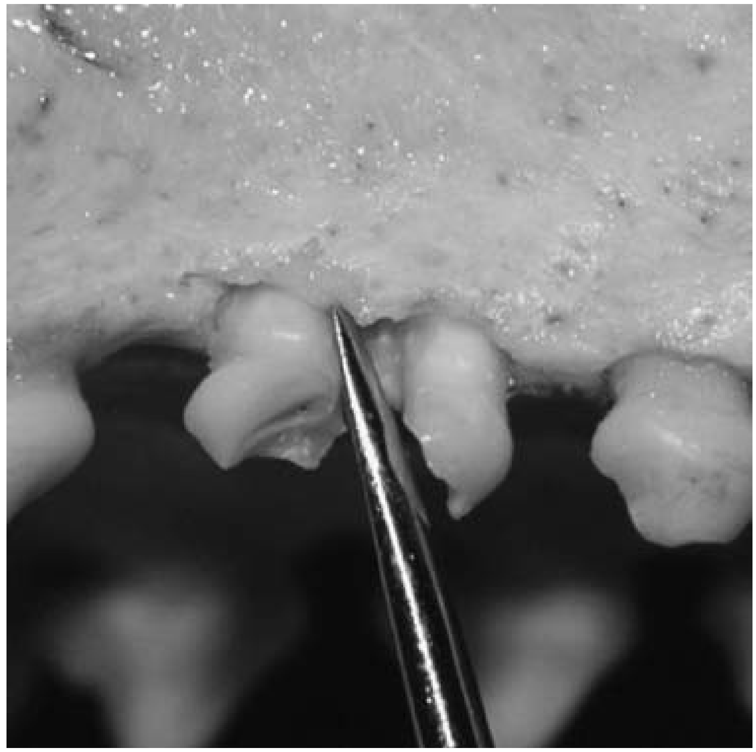


Figure 5.45 The Luxator® and elevator can be used between the two crown segments without the danger of crown or root fracture as a result of leverage forces on the crown.

bulge' of the tooth to be extracted can be removed using a high-speed bur to create space and improve access to the periodontal ligament.

A surgical flap is raised to expose alveolar bone and allow alveolotomy to expose the roots of the tooth to be extracted (Figure 5.46). An envelope flap or larger flap can be raised, with one or two releasing incisions. In the experience of the author a flap is easily raised by introducing a periosteal elevator under the periosteum of the alveolar mucosa. Once the alveolar periosteum has been raised, the periosteal elevator should be advanced under the attached gingiva and through the previously severed gingival epithelial attachment. If approached from the attached gingiva side, the periosteal elevator may be inadvertently advanced through the mucogingival junction destroying the flap.

Flaps must have wide bases, take important structures into account (neurovascular, salivary glands and ducts etc.), be protected from the bur and closed in such a manner that they are not under any tension. It is better for flaps not to begin over the furcation of a tooth or on the inter-dental papilla (Figures 5.47 and 5.48). Ideally, flaps should begin at the line angle (Figure 5.49) of the adjacent tooth and run perpendicular to the alveolar margin into the surrounding alveolar mucosa making a curved junction with the gingival incision. Having a curved 'point' aids in suturing of the flap and maintains blood supply to the edge of the flap. (Line angles are the junction of two perpendicular surfaces of a tooth and are defined as follows: mesio-lingual / palatal, mesio-buccal, disto-buccal and disto-lingual / palatal, disto-occlusal, linguo / palato-occlusal, mesio-occlusal and bucco-occlusal.)

The epithelial attachment is severed as described for simple extraction technique (p. 145) and the incision extended rostrally and caudally providing sufficient access to the affected tooth alveoli / alveolus. The perpendicular

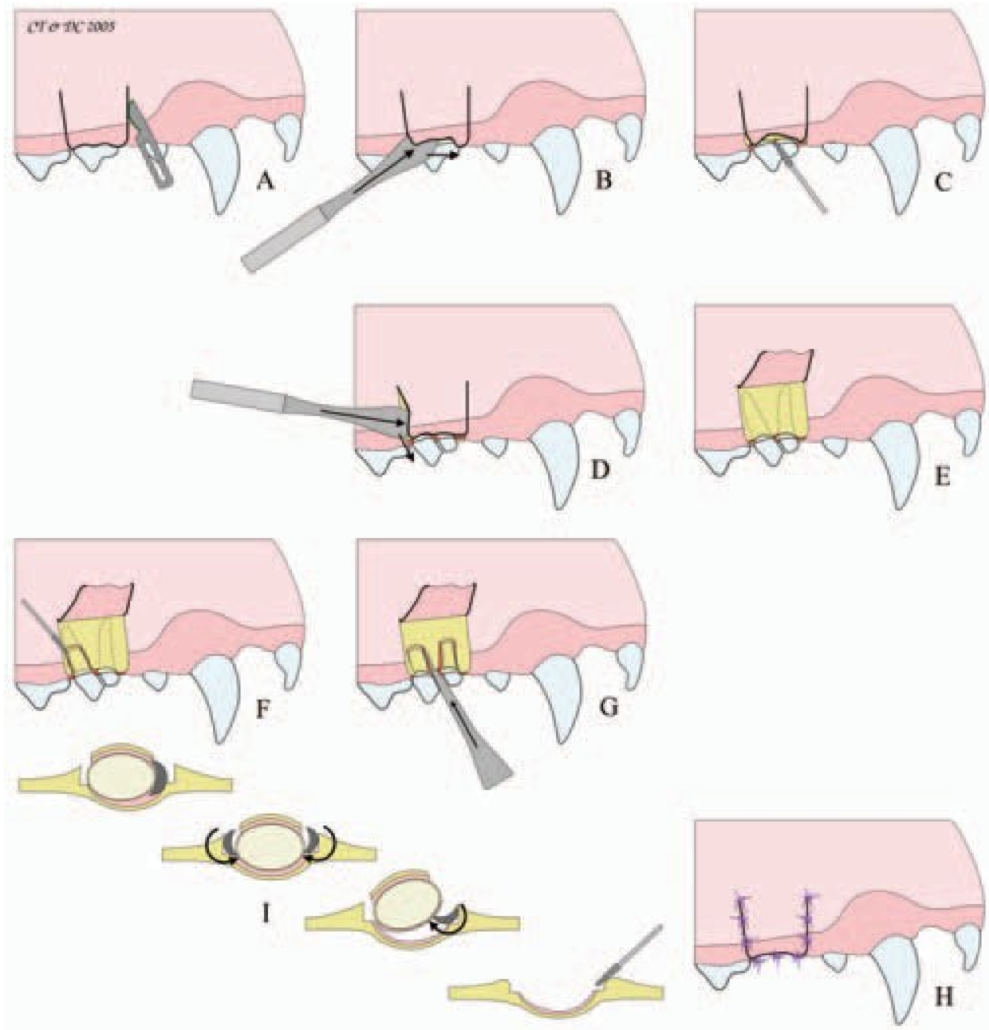


Figure 5.46 Mucoperiosteal flap access for extraction of multi-rooted teeth.
A: The gingiva is incised by placing the scalpel blade into the gingival sulcus / pocket and incising down to the alveolar margin. The releasing incisions are made perpendicular to the gingival margin and at the line angles of the tooth / teeth to be extracted or the adjacent teeth.
B: A small envelope flap is raised to expose the furcation of the tooth to be extracted.
C: The crown of the tooth to be extracted is sectioned from the furcation through the crown and a wedge of crown may be removed.
D: The mucoperiosteal flap is raised by inserting the periosteal elevator under the periosteum apical to the mucogingival line and working it in a coronal direction before progressing rostrally and caudally.
E: The flap is raised and reflected to reveal the juga (bony alveolar bulge) over the roots.
F: Alveolotomy is performed to expose the periodontal ligament for a distance of about three quarters of the length of the roots.
G: Luxation and elevation of the crown / root segments is performed.
H: The flap is closed without tension, using synthetic monofilament absorbable suture material. If there is tension in the flap, a periosteal releasing incision should be made as described in Figure 5.43.
I: (Top to bottom): The tooth is luxated and then elevated using alveolar bone as a leverage fulcrum. Alveoloplasty is performed prior to flap closure to prevent damage to the flap from sharp alveolar edges.

releasing incisions should be extended through the mucosa to an appropriate level (usually about three quarters of the length of the juga (bony alveolar bulge over root)). Buccal (and lingual / palatal if need be) alveolar bone should then be removed to expose the furcation from which the tooth will be

Figure 5.47 The furcation is that part of a multi-rooted tooth where the roots diverge from the neck. Incising the gingiva over the furcation area will compromise the tooth.

Figure 5.48 The gingival papilla is that part of the gingiva which extends coronally between two adjacent teeth.

sectioned through the crown. Buccal alveolar bone should be removed from over the root for about three quarters of the length of each root. Furcation bone should be removed to create access to the periodontal ligament. Initially, a Luxator® should be used to sever the ligament followed by leverage activity

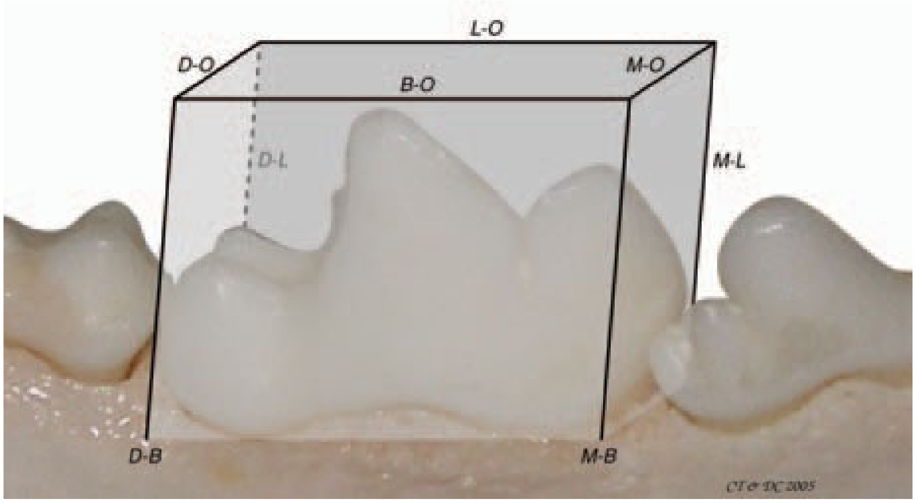


Figure 5.49 Line angles are the intersection of perpendicular surfaces: M-B = mesio-buccal; M-L = mesio-lingual; D-B = disto-buccal; D-L = disto-lingual; M-O = mesio-occlusal; B-O = bucco-occlusal; D-O = disto-occlusal; L-O = linguo-occlusal.

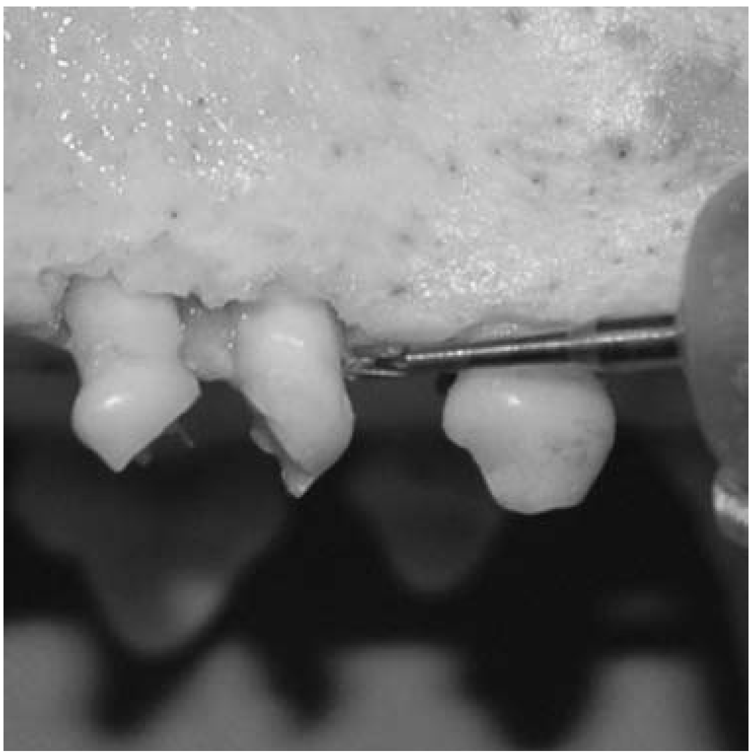


Figure 5.50 A shallow slot can be burred into the neck of a tooth to give added purchase for elevation.

using an elevator. If the tooth does not loosen sufficiently more buccal alveolar bone can be removed to facilitate access to the more apical part of the root rather than risk fracture of the root. A shallow slot can be burred into the neck of the tooth to create a ledge against which the elevator can engage using the alveolar margin as a fulcrum (Figures 5.50–5.52). Once sufficiently loosened, the root can be delivered using the elevator or gentle use of extraction forceps.

When both roots have been extracted alveoloplasty should be performed to remove any sharp alveolar edges and loose alveolar bone using a large, round

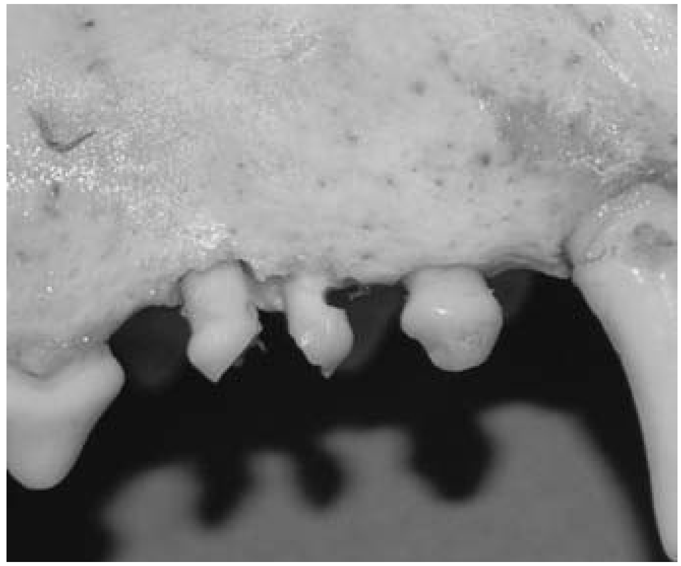


Figure 5.51 Slot burred into the neck of the tooth.

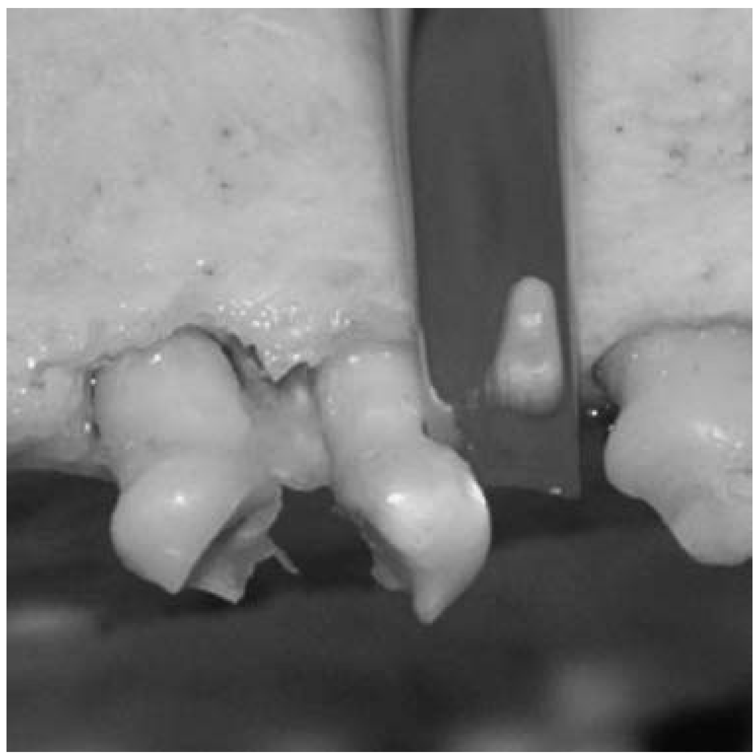


Figure 5.52 The side of the elevator is engaged into the slot and rotational force is applied to deliver the tooth from its alveolus.

diamond bur (Figure 5.53). The flap should be closed without tension. If for some reason the flap is under tension, a releasing incision should be made through the periosteum at the base of the flap (apical to the mucogingival junction) (see Figure 5.43). This will allow the flap to advance significantly and enable tension-free closure. The palatal (lingual) gingiva should also be raised from the bone to facilitate alveoloplasty and flap closure.

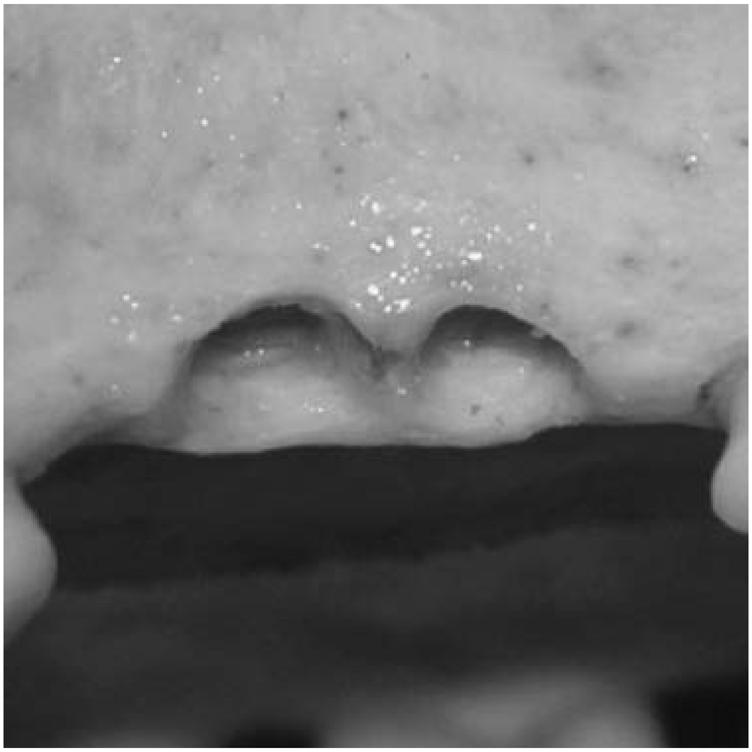


Figure 5.53 Alveoloplasty is performed prior to flap closure to prevent damage to the flap from sharp alveolar edges.

Extracting three-rooted teeth

The maxillary carnassial and molar teeth usually have three roots in dogs. In the cat the maxillary carnassial has three roots and although the maxillary molar may have two or three roots the buccal roots are usually fused. Care must be exercised when extracting this tooth using the simple extraction technique.

A surgical flap should be raised as described in the section on extraction of two-rooted teeth above. The palatal crown-root segment should be sectioned from the tooth neck prior to sectioning of the buccal crown-root segments (Figures 5.54 and 5.55). This is especially important in molar teeth to ensure the palatal cusp is not inadvertently sectioned which would lead to root fracture during extraction. The buccal crown-root segments are then sectioned followed by removal of furcation bone creating access to the periodontal ligament (Figures 5.56–5.59). Once the buccal roots have been extracted, furcation bone buccal to the palatal root should be removed to facilitate access to this root (Figure 5.60). It is important to remember to incise the epithelial attachment circumferentially around the palatal cusp as well because this attachment can be particularly strong around these crowns. A releasing incision is usually required in the periosteum of the buccal flaps to permit closure of the wide resultant defect.

It is preferable to perform alveoloplasty using a large, round diamond bur, as it not only rounds off the alveolar bone efficiently but is also less likely to cause trauma to the soft tissues. Adequate irrigation is essential to prevent alveolar bone necrosis from frictional heat.

As much alveolar bone as possible should be maintained to prevent jaw weakening especially in those jaws compromised by severe periodontal disease.

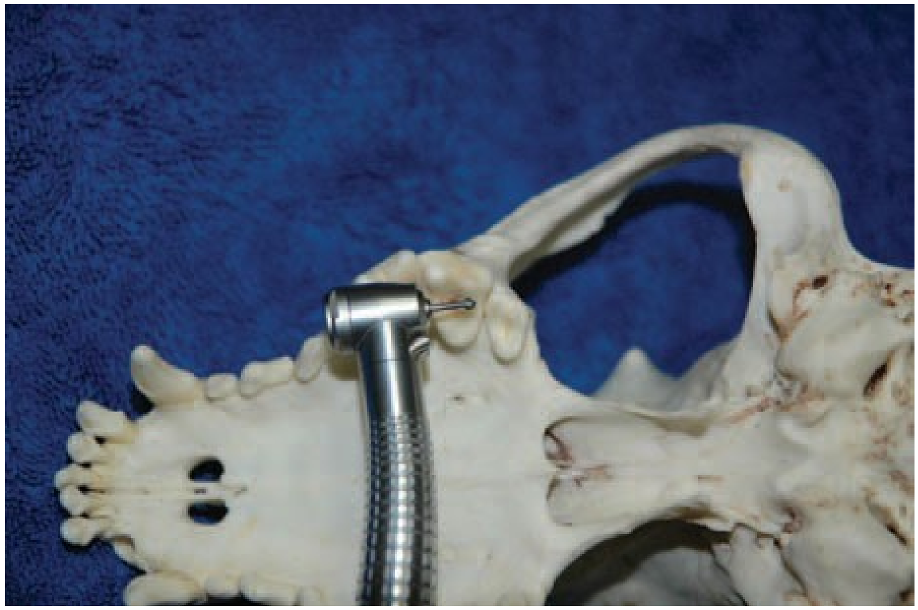


Figure 5.54 The palatal cusp of the maxillary left molar 1 is being sectioned.

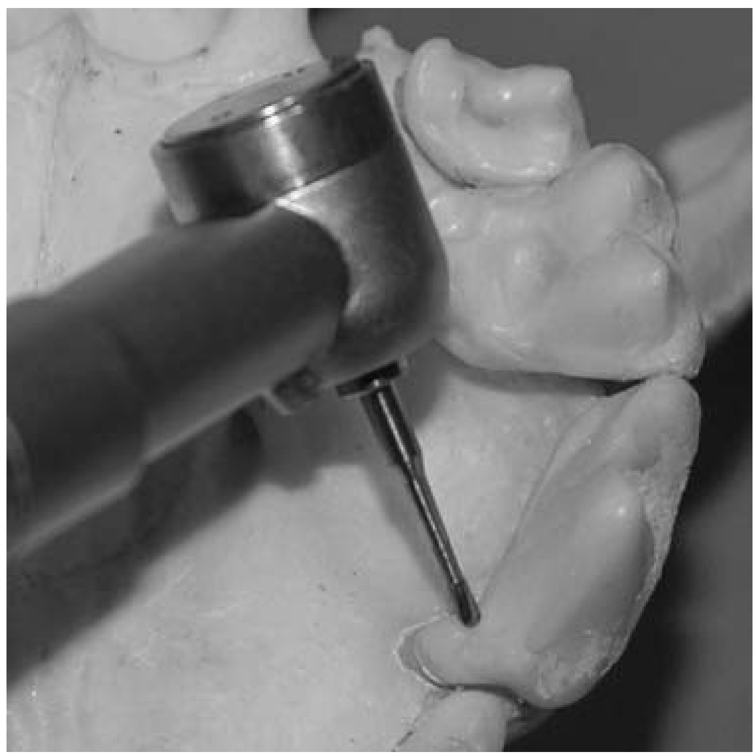


Figure 5.55 The palatal cusp of maxillary right carnassial is being sectioned. The bur should be directed at about 45° between the palatal and buccal cusps.

When 'important' teeth (canines and carnassials) have been extracted, occlusion of the remaining teeth must be evaluated to ensure that they do not cause trauma to the opposing tissues. The mandibular carnassial tooth (molar 1) may bite into the palate after the maxillary carnassial tooth (premolar 4) and molar 1 have been extracted. This tooth may require odontoplasty to shorten the crown to prevent palatal trauma.

Figure 5.56 The buccal cusps of the maxillary right molar 1 are being sectioned.

Figure 5.57 The buccal cusps of the maxillary right carnassial tooth are being sectioned.

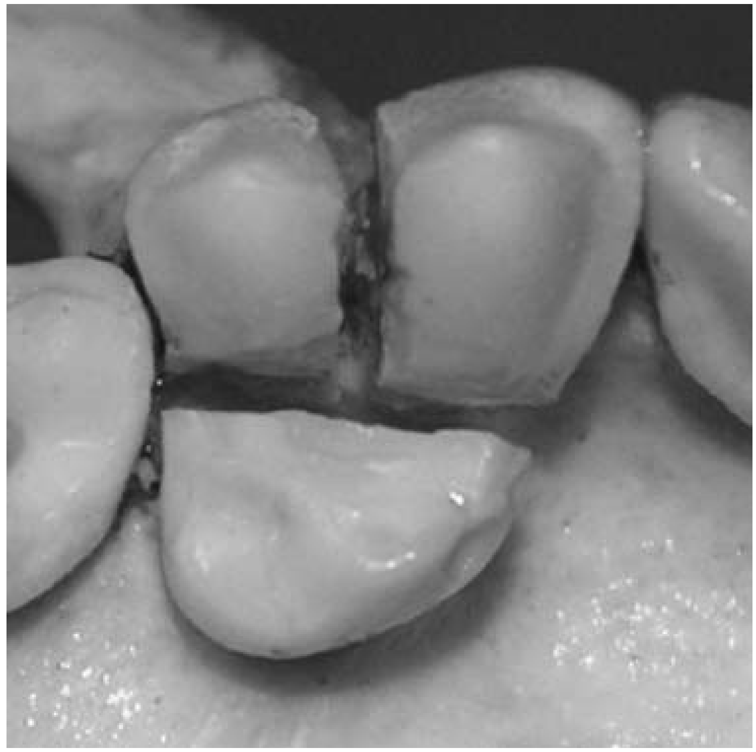


Figure 5.58 The three crown segments of maxillary right molar 1.

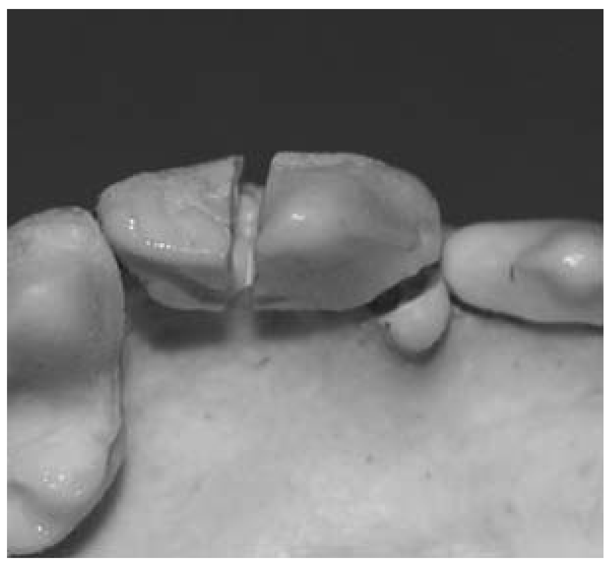


Figure 5.59 The three crown segments of maxillary right carnassial tooth.

Extracting persistent deciduous teeth

Deciduous teeth are considered persistent when they are present in the mouth together with their succedaneous counterpart. In other words if two teeth occupy the same location the deciduous tooth must be extracted. Persistent deciduous teeth may be found to be unassociated with a succedaneous tooth in the dentition of old animals and in these cases this tooth is kept in the mouth as to extract it would reduce the number of functional teeth (Figure 5.61). Pre-operative radiographs of persistent deciduous teeth are

Figure 5.60 Once the buccal crown / root segments of the maxillary carnassial tooth have been extracted, furcation bone buccal to the palatal root must be removed to facilitate extraction of this crown / root segment.

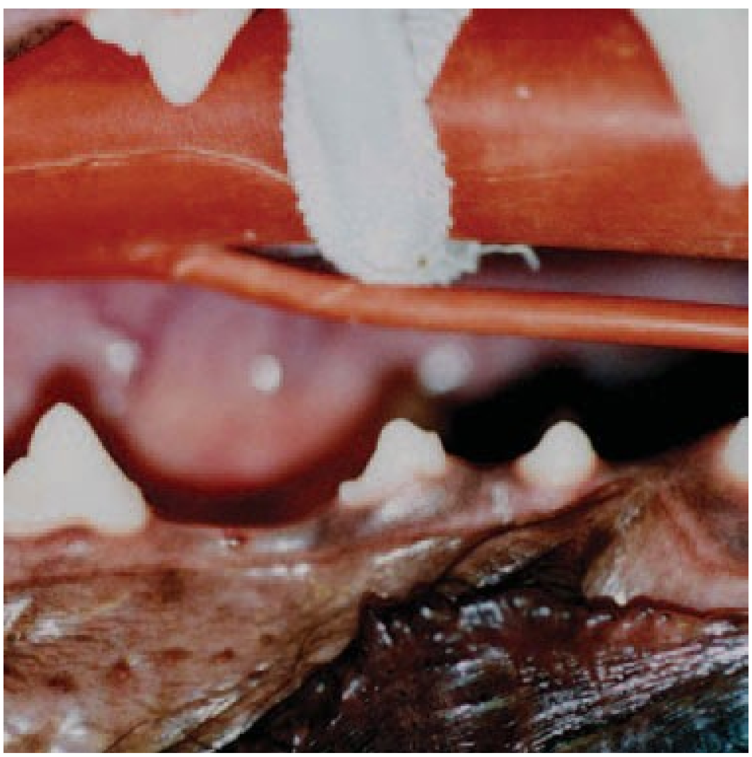


Figure 5.61 Persistent deciduous teeth unassociated with succedaneous permanent teeth (confirmed radiographically) may be kept in the mouth as they are often functional. This mandibular persistent deciduous premolar 2 is a functional tooth in this mixed dentition. Permanent premolar 2 is missing.

essential (Figure 5.62) as some may be undergoing root resorption and their extraction is accomplished by simply severing the gingival attachment, either using a scalpel blade or a sharp Luxator®. When the roots are visible radiographically, surgical extraction is indicated (Figure 5.63).

Figure 5.62 Persistent deciduous teeth must be radiographed prior to the mucoperiosteal flap being raised for their extraction. In some cases, as in this mandibular right persistent deciduous canine (804), the root has already undergone resorption and extraction is performed by severing the gingival attachment using a scalpel blade.

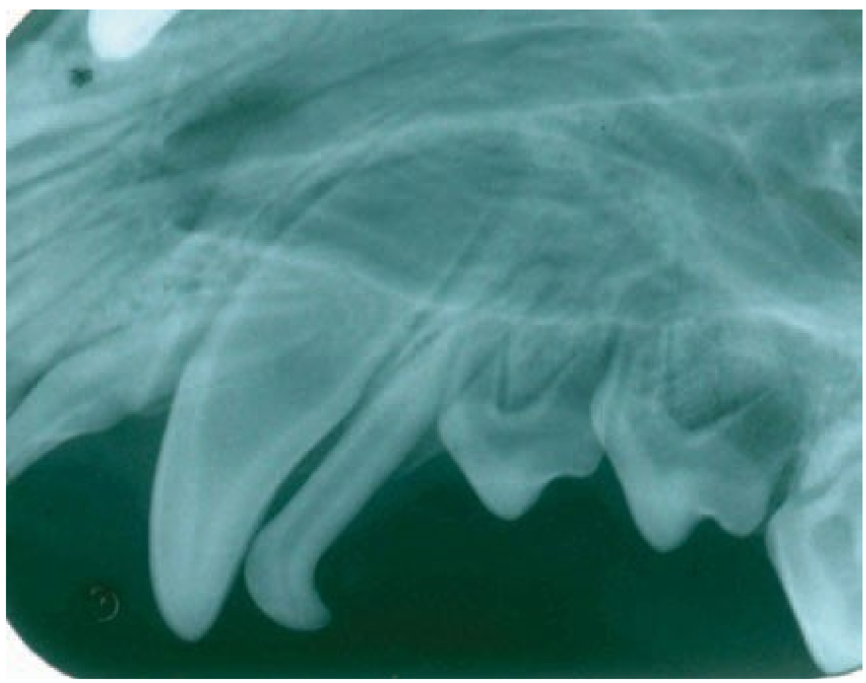


Figure 5.63 Persistent deciduous canine teeth which have been shown to have their roots intact should be extracted surgically.

The surgical flap is raised as described earlier but must be extended to expose the full extent of the deciduous tooth root (Figure 5.64). The deciduous canine crown comprises approximately 25–30% of the tooth with the root making up the remaining 70–75% (Figure 5.65). Once the flap is raised

Figure 5.64 A large mucoperiosteal flap is raised as described previously, exposing the full extent of the persistent deciduous canine juga.

Figure 5.65 The deciduous canine tooth comprises about 25–30% crown and 70–75% root!

and the alveolar juga exposed, an alveolotomy is performed around the whole root beginning mesially at the neck of the tooth and ending distally at the neck of the tooth (Figure 5.66). Sufficient bone is removed to expose the periodontal ligament which is then incised using a scalpel blade (Figure 5.67). Once the gingival attachment has been incised on the palatal / lingual aspect of the tooth, it can often be lifted from the alveolus using the forefinger and thumb. Gentle luxation is required in some cases but care must be exercised not to place the luxation instrument between the crowns of the deciduous and

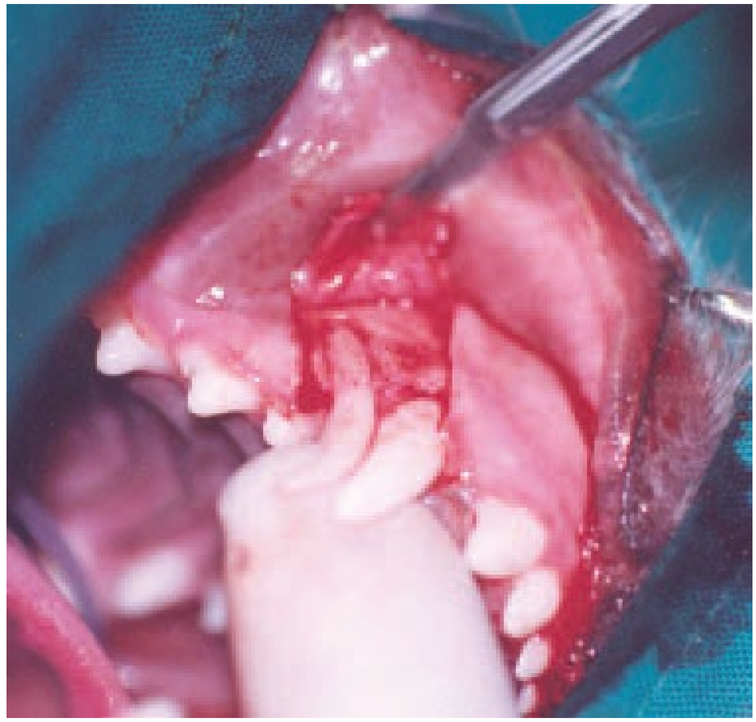


Figure 5.66 Alveolotomy is performed around the whole juga, exposing the periodontal ligament.

Figure 5.67 The periodontal ligament is incised using a scalpel blade and once the palatal / lingual-attached gingiva is incised, the tooth can often be delivered from the alveolus using the thumb and forefinger.

permanent teeth (Figure 5.68). This may create undue pressure on the unerupted part of the permanent tooth and can result in enamel hypomineralisation due to damage inflicted on the cells that aid in enamel mineralisation and maturation. The alveolar edges should be gently smoothed and the tension-free flap closed.

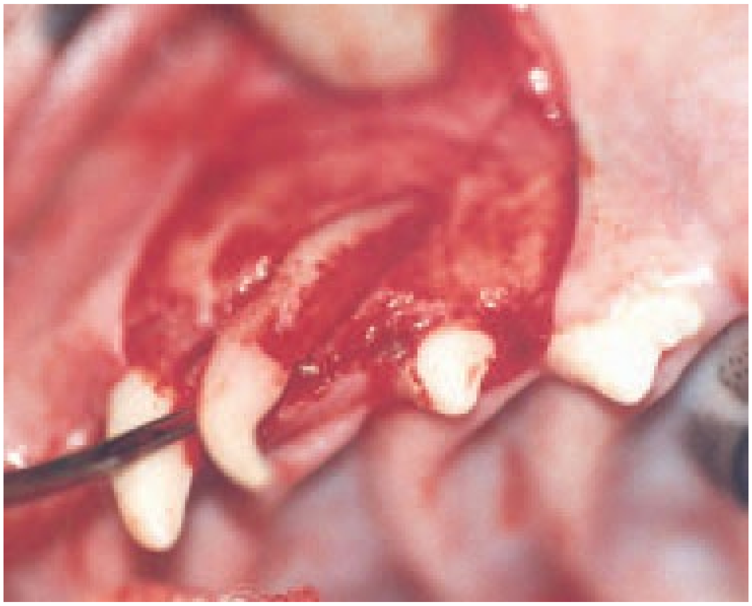


Figure 5.68 Do not place a Luxator® between the crowns of the deciduous and permanent teeth as it may cause damage to the enamel organ or mineralising enamel and present as enamel defects or discolouration when the permanent tooth erupts.

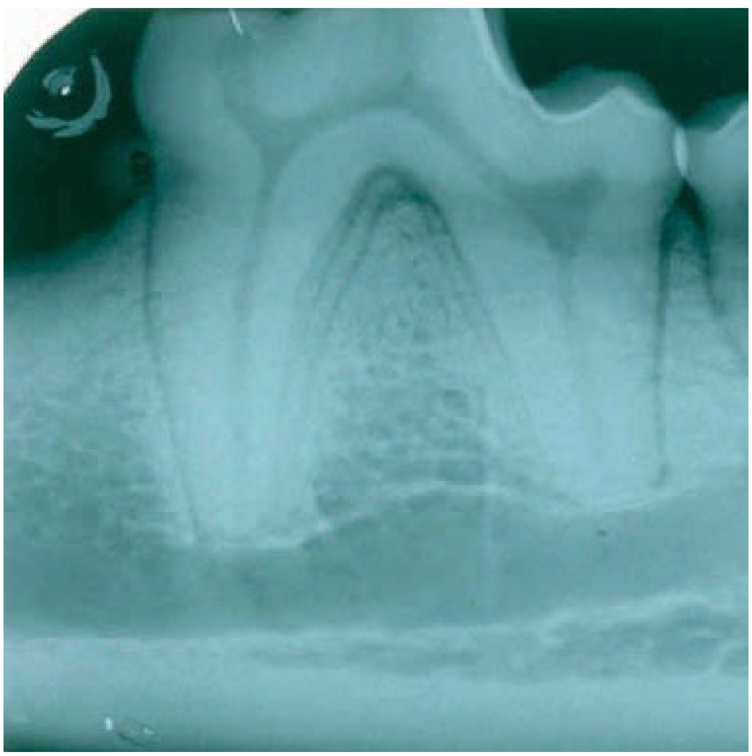


Figure 5.69 The carnassial teeth have longitudinal developmental grooves (distally on the mesial root and mesially on the distal root) which improve anti-rotational stability. These can complicate extraction of these teeth.

Possible complications associated with extractions

The mandibular molar 1 and maxillary carnassial tooth roots can have a developmental groove running from the furcation to the apex of the root (Figure 5.69). These grooves provide additional anti-rotational support to these teeth and can result in their extraction taking longer than expected.

On pre-operative radiographs the developmental groove in a mandibular molar 1 appears as parallel lines at the distal aspect of the mesial root. Removing additional furcation bone will facilitate extraction of these roots.

In geriatric animals the periodontal ligament space is narrower than in young animals and the alveolar bone more dense. This can complicate extraction as access to the periodontal ligament space is limited and the alveolar bone is not easily compressed during luxation and elevation. It is therefore necessary to perform a wider and deeper alveolotomy to create space for the Luxator® and elevator. Greater patience is also required to prevent iatrogenic root / crown fractures. It is also advisable to remove more buccal alveolar bone in geriatric animals to expose a greater length of root prior to luxation and elevation. Periodically, roots in geriatric animals may be ankylosed to the alveolus although this may not be readily visible radiographically (because of the two-dimensional view).

Iatrogenic oro–nasal communication often occurs when periodontally compromised maxillary teeth are extracted as a result of bone loss affecting the palatal alveolar wall. Sometimes the only separation between the tooth and the nasal passage is inflamed soft tissue which tears loose during extraction. Bleeding is usually noticed from the ipsilateral nostril. Primary closure of these acute communications is the treatment of choice (Figures 5.70 and 5.71). In some cases it is necessary to debride inflamed epithelialised tissue (pocket wall) from the alveolus before the defect is closed using an advancement flap. See Chapter 7 – Oral Surgery, for details.

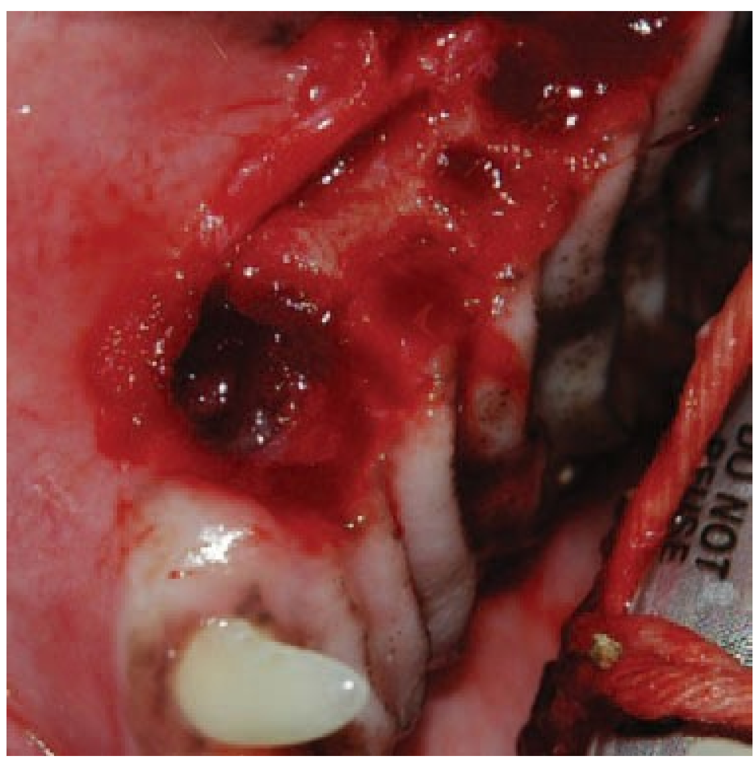


Figure 5.70 A mucoperiosteal flap was raised to extract the maxillary left canine and premolars and an oro-nasal communication resulted at the canine alveolus. The nasal passage was visible through the alveolus.

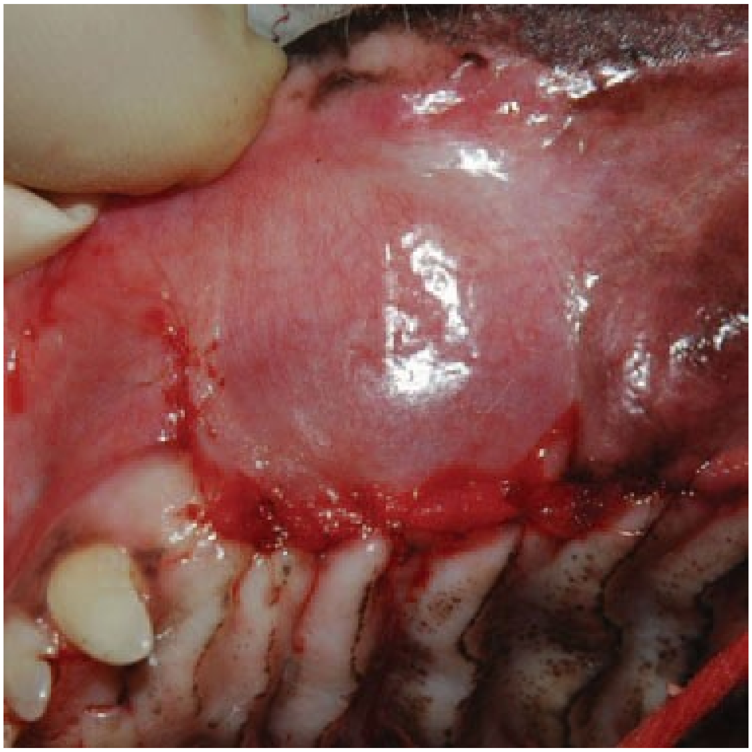


Figure 5.71 The acute oro–nasal communication was repaired by tension-free closure of the mucoperiosteal flap and healed uneventfully.

Further reading

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6 Jaw Fracture Repair

Mandibles do not have a medullary cavity. The mandibles house a number of important structures, namely the teeth and inferior alveolar neurovascular structures (coursing through the mandibular canal) which complicate repair of mandibular fractures. In young animals with deciduous dentition there is even less space in the mandibles for fracture fixation devices because the developing permanent dentition occupies most of the mandible. The muscles of mastication insert on the mandibles.

Jaw fractures are common following motor vehicle accidents and dog fights. Jaw fractures are usually secondary to trauma although pathological fractures are seen periodically in geriatric animals with severe periodontal disease which has compromised the jaws. The majority of fractures occur in the body of the mandible and often involve teeth (Figure 6.1 A–D).

The masseter and temporal muscles and those that open the jaw (and gravity) apply opposing forces to the jaw and these will either aid in compression of the fracture fragments or their distraction (Figure 6.2 top). The dorsal aspect of the mandible is the tension side and the ventral margin is the compression side (Figure 6.2 bottom). Jaw fractures are usually described as stable (favourable) or unstable (unfavourable) depending upon the orientation of the fracture. A stable fracture is one that has a caudo-dorsal to rostro-ventral orientation. An unstable fracture has a caudo-ventral to rostro-dorsal orientation (Figure 6.3). A left mandibular fracture will result in the lower jaw shifting to that side (also seen when the right temporomandibular joint becomes luxated) and vice versa.

When teeth are involved in the fracture line their exact involvement is crucial in deciding whether they are to be retained to aid in fracture repair stability, or whether they should be extracted. If the fracture line follows the root surface but does not expose the apex, the tooth should be retained in the mouth and re-evaluated radiographically within three months (Figure 6.1 E, F, G). If the apex of the tooth is exposed the tooth should either be extracted or the exposed root resected and root canal therapy performed on the remaining root if it will aid in fracture repair stability. This case may need to be referred

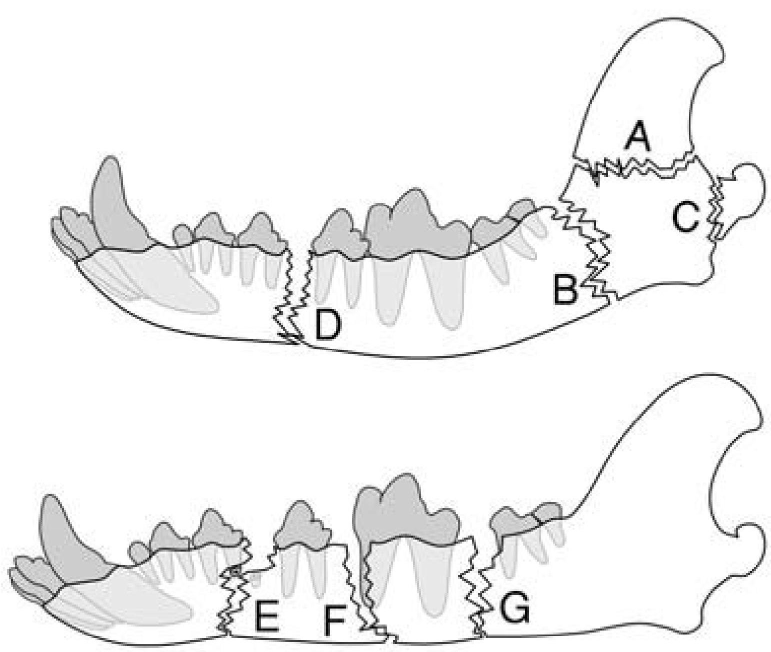

Figure 6.1 Common sites for jaw fractures:
A: coronoid process;
B: junction of ramus and mandibular body;
C: condylar process;
D: body of the mandible.
Tooth involvement in fractures:
E: fractures may involve fracture of the tooth roots as well;
F: fractures may expose the apical delta often severing the pulp communication with the periodontal ligament. These teeth require root canal therapy if they are to be maintained in the mouth.
G: fractures may expose part of a root but if the apex is not exposed then these teeth can be maintained in the mouth. Follow-up radiography is advisable to monitor teeth affected in this way.

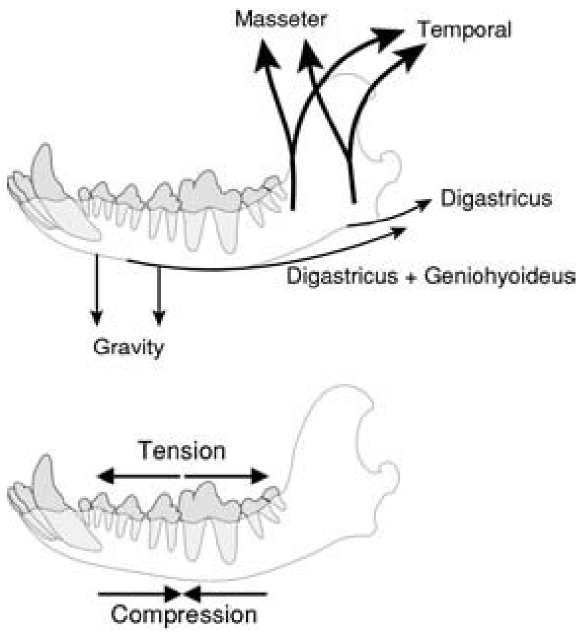

Figure 6.2 The mandibles are subject to opposing forces. The masseter and temporal muscles close the mouth while the digastric and geniohyoid muscles and gravity open the mouth. The dorsal margin of the mandible is the tension side while the ventral mandibular margin is under compression.

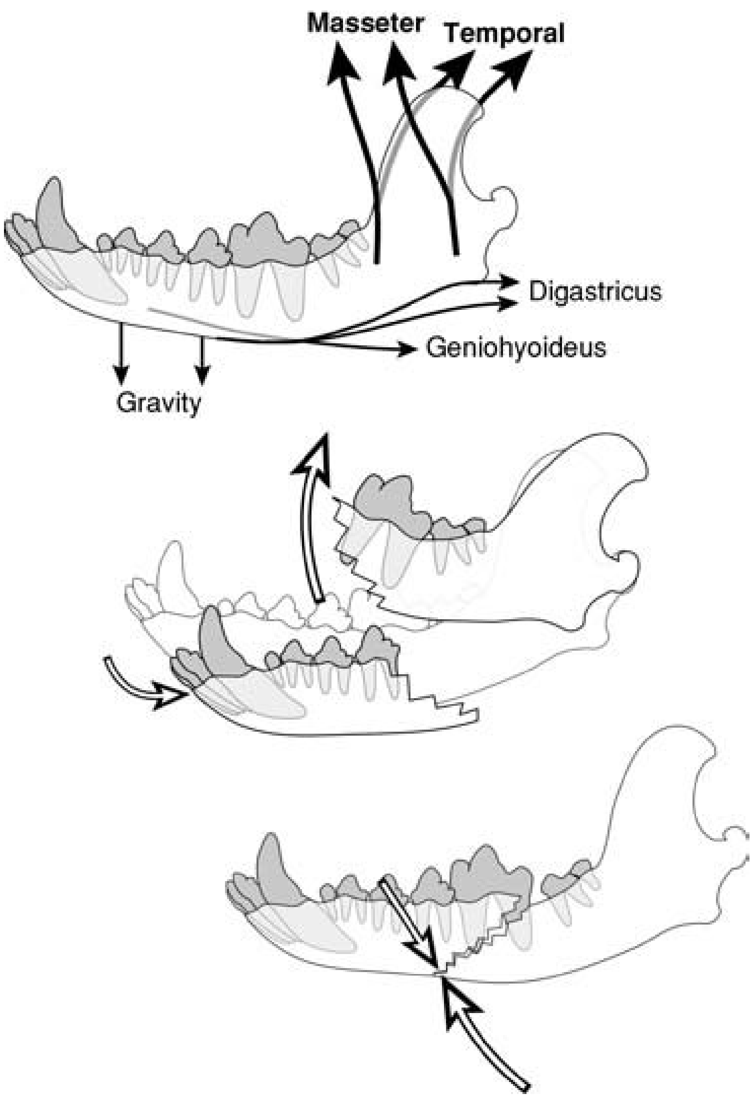

Figure 6.3 The forces acting on the mandible cause fractures to be classified as favourable or unfavourable depending upon their orientation. A fracture with a rostro-dorsal to caudo-ventral orientation is an unfavourable fracture as the forces acting on the jaw distract the fragments. A rostro-ventral to caudo-dorsal fracture is a favourable orientation as it leads to compression of the fragments at stabilisation.

to a colleague who can perform endodontic treatment on the remaining section of the tooth.

Fracture repair techniques

Tape or fabric muzzle

The tape muzzle is used to keep the jaws stabilised and the teeth in occlusion. The initial layers of tape (zinc oxide tape is best as it does not shrink significantly when wet) are placed with their sticky side away from the animal's skin (it is undesirable for the tape to adhere to the patient's skin or facial hair). The loop around the muzzle must be small enough to prevent the canine teeth from coming out of occlusion but large enough to allow the animal to lap food and water (and pant when warm). The loop extending from the muzzle around the back of the ears must keep the muzzle loop from sliding down the nose. The second layer of tapes is placed with the sticky side adhered to the sticky layer of the initial layers of tape (Figure 6.4).

Fabric muzzles are available which support the mandible while keeping the canines in occlusion (Figure 6.5).

The management of tape and fabric muzzles is of paramount importance. After each meal the muzzle must be removed, cleaned and replaced once the animal's face has been cleaned and dried. Wet muzzles lead to facial skin maceration and dermatitis. Alternatively, two or three muzzles can be used and rotated (with the used muzzle washed and allowed to dry for use again). Tape and fabric muzzles are not only ineffective in brachycephalic breeds due to their head and face shape, but are also contra-indicated as these breeds often rely on open-mouthed breathing for efficient respiration.

Inter-fragmentary wiring

Inter-fragmentary wiring may be performed as long as it is possible to place the wires without compromising tooth roots. The wire can be placed using either a two-, three- or four-hole configuration. In the two-hole configuration

Figure 6.4 A tape muzzle in place. These must be removed after the animal has eaten and once the face has been cleaned, a clean, dry muzzle must be fitted. The animal should not be left unattended between muzzle changes.

Figure 6.5 Fabric muzzles are very useful in mandibular stabilisation. This muzzle has been worn for four weeks. The fraying is due to the patient rubbing it in an attempt to get it off! The owner diligently replaced the muzzle with a clean one after each meal, thus preventing muzzle associated dermatitis.

the wire is placed perpendicular to the fracture line while in the three-hole configuration, one hole is placed in the caudal fragment and two holes are placed in the rostral fragment lending greater stability to the repair. The dorsal wire is placed close and parallel to the dorsal alveolar margin and the ventral wire is placed perpendicular to the fracture line. In the four-hole technique, two wires are placed parallel to each other and perpendicular to the fracture line (Figure 6.6).

Inter-dental wiring

Inter-dental wires may be used to stabilise adjacent teeth or numerous teeth in a quadrant.

Place a loop of wire between the teeth on either side of the fracture line and then pass the free ends around the mesial and distal aspects of these teeth. Take the free end which has come around the distal aspect of the caudal tooth and pass it through the loop (passing between the two teeth) and tie it to the free end at the mesial aspect of the rostral tooth. Once the free ends have been twisted together the inter-dental loop should be twisted to complete the fixation. This pattern can be extended to include all teeth in a quadrant and under some circumstances extend to the contra-lateral side to improve stability (Figures 6.7 and 6.8). Inter-dental wiring may also be performed by placing a wire mesially around the rostral tooth and distally around the caudal tooth to be stabilised and the loose ends twisted together (Figure 6.9).

Inter-dental acrylic

An inter-dental acrylic splint can be applied to the teeth on either side of a fracture to provide rigid inter-fragmentary fixation as long as there are teeth

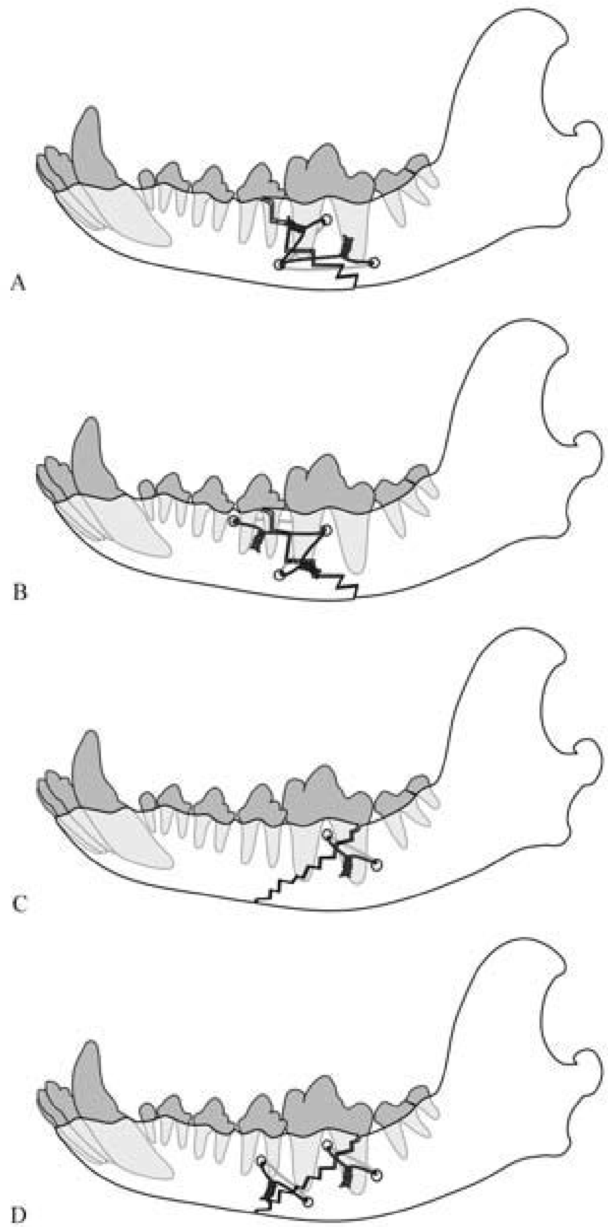

Figure 6.6 Inter-fragmentary wiring. A: Although this three-hole arrangement is correctly placed according to tooth roots, it does not provide as much stability as the arrangement in B.
B: This arrangement of the three-hole wire placement makes use of the biomechanical forces on the jaw to improve stability. The dorsal wire is parallel to the tension side and the ventral wire is perpendicular to the fracture line.
C: The two-hole wire placement for favourable fracture stabilisation. The wire is perpendicular to the fracture line and anchored rostrally close to the tension side.
D: The four-hole wire placement configuration. Both wires are arranged perpendicular to the fracture line. Care should be taken not to place a wire through a tooth root or the mandibular canal.

on either side of the fracture. The bulk of the acrylic should be applied to the buccal surface of maxillary teeth (maxillary stabilisation) and the lingual surface of mandibular teeth (mandibular stabilisation) to prevent interference with occlusion. When using material which undergoes an exothermic reaction it is important not to place too thick a layer against the tooth at one time, or thermal induced pulpitis may result. When using exothermic material, incremental layers should be applied until the desired thickness is attained (Figure 6.10). Circumferential orthopaedic wire can be placed around the mandible and incorporated into the acrylic to provide stabilisation in edentulous areas.

Inter-arcade acrylic bonding between mandibular and maxillary canines is sometimes indicated. This technique may require a combination of inter-fragmentary wiring and inter-dental acrylic in order to be effective. The canines are bonded together using dental acrylic or dental restorative material

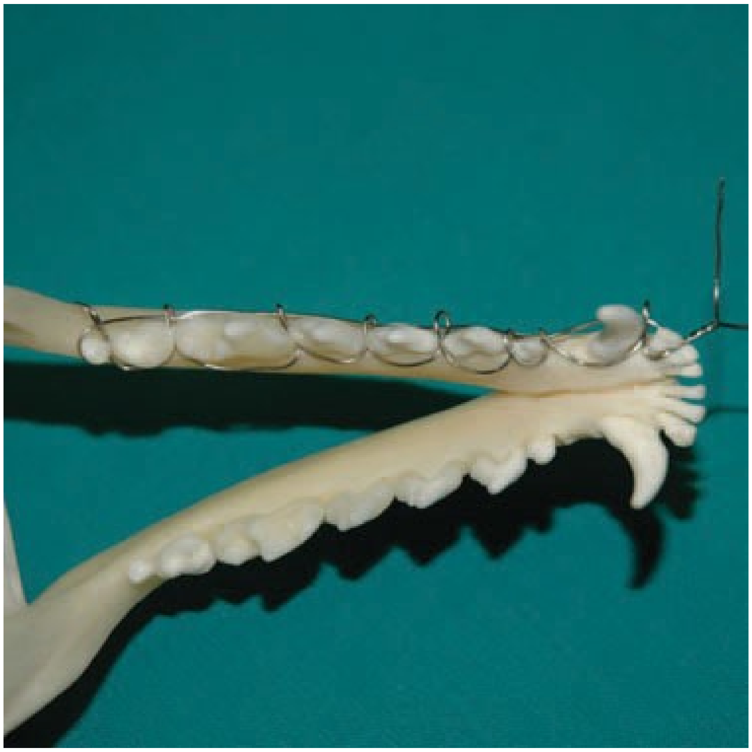

Figure 6.7 The inter-dental loop wiring technique. Orthopaedic wire is passed distally around the last molar and courses rostrally on the buccal aspect of the teeth. The lingual wire is passed between molars 1 and 2 and over the buccal wire and back between these teeth. This pattern is continued as far as stabilisation is required. This may cross the mandibular symphysis if required.

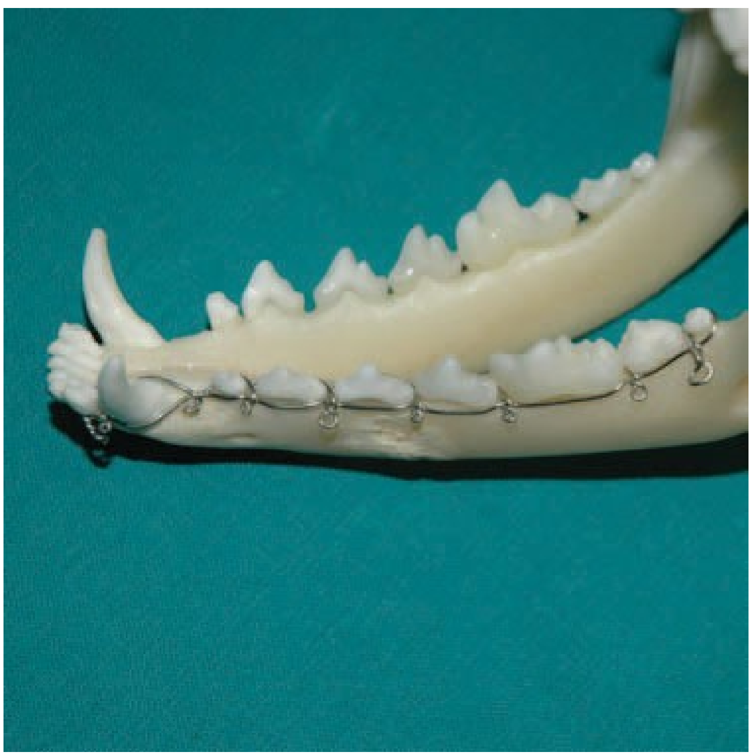

Figure 6.8 The two loose ends of the wire are twisted together and then each loop protruding buccally around the buccal wire is twisted in turn until desired stability is attained. The loops can then be bent ventrally so that they do not irritate or traumatise the cheek mucosa.

with the jaws held apart sufficiently to allow lapping of food but not so far apart as to prevent swallowing. Prior to bonding the teeth together, the endotracheal (ET) tube must be untied and the tie loosened from the tube to prevent obstruction once the tube is removed during recovery from anaesthesia. It is also important to ensure that the cuff inflation tube is positioned

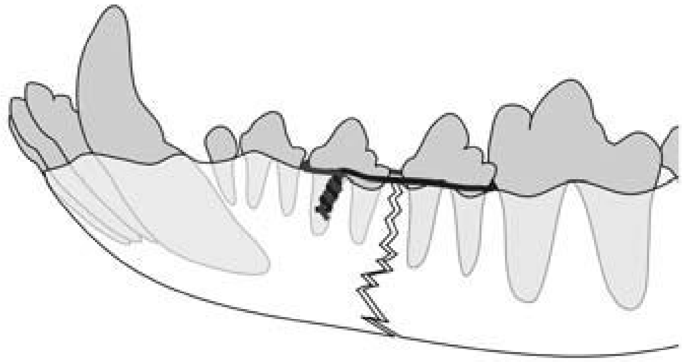

Figure 6.9 A single loop of wire can be placed mesially around the rostral tooth and distally around the caudal tooth on either side of a fracture line and the loose ends tightened appropriately.

Figure 6.10 Interdental acrylic can be used to form a 'rigid' fixation device. The bulk of acrylic should be placed lingually for mandibular stabilisation and buccally for maxillary stabilisation in order to prevent interference with occlusion.

alongside the ET tube between the canines or else it will become trapped at extubation. Placement of an oesophageal feeding tube is important to maintain caloric intake until the patient learns to prehend and swallow food. When patients have severe swelling in the caudal oral cavity (often associated with concurrent temporomandibular joint pathology) inter-arcade bonding should be delayed until the swelling has subsided or the patient may suffer respiratory compromise.

Orthopaedic wires and pins should not be placed within the mandibular canal under any circumstances (as one may perform pinning of another bone) as they will cause severe damage to the inferior alveolar blood vessels and nerves which course through the mandibular canal. When applying orthopaedic principles to mandibular fracture repair the fact that the dorsal margin of the mandible is the tension side would suggest that fixation devices must be placed closer to the dorsal margin. However, the teeth roots are

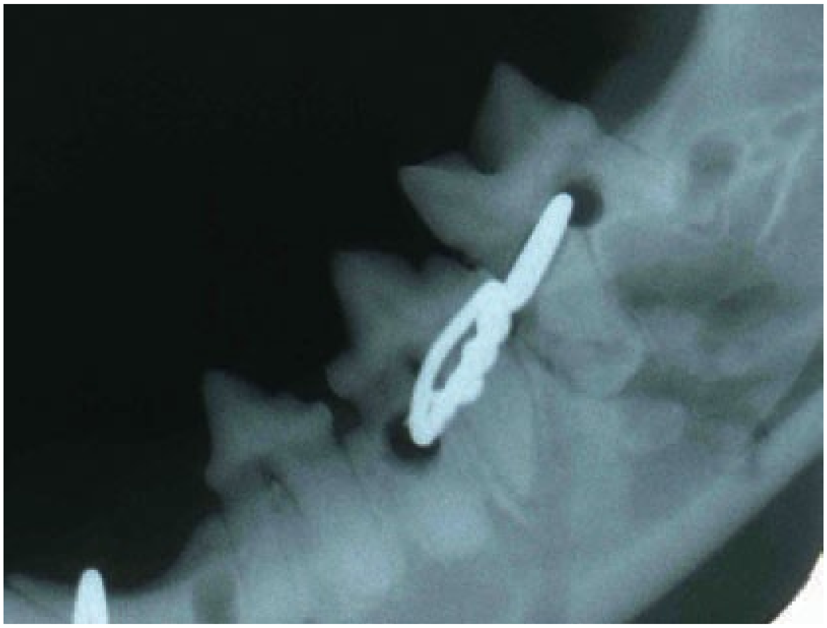

Figure 6.11 Holes must not be drilled blindly through the mandibles. Three holes have been drilled through this mandible: one through the mesial root of the mandibular left premolar 4, one through the mesial root of the adjacent molar (beneath the wire) and the third through the furcation of the molar. All of these placements have compromised the teeth.

housed within the dorsal half of the mandible and this precludes the use of bone plates and screws. External fixators may be used and the pins placed between roots according to root positions confirmed radiographically. Pins should not be placed through tooth roots. If an external fixation pin is to be placed through the mandibular canal then the diameter of the chosen pin must be less than half the width of the canal in order to prevent damage to the inferior alveolar neurovascular bundle. Pins should be driven using a Jacobs chuck to prevent damage to these structures and must be placed either at the dorsal (preferably) or ventral margin of the canal. Inter-fragmentary wires may be placed through one cortex of the canal. The neurovascular contents must be protected from the drill by using a retractor. Holes must not be blindly drilled through the mandible as this inevitably results in damage to vital structures (Figures 6.11 and 6.13).

Soft-tissue injuries must also be addressed when treating jaw fractures. Commonly seen soft tissue injuries include stripping of the gingiva, alveolar mucosa and periosteum from the body of the mandible. Careful debridement of compromised tissue should be performed prior to suturing the soft tissues. The tongue and sub-lingual mucosa and associated tissues can also be damaged and should be thoroughly cleaned and treated appropriately (Figure 6.14).

Caloric intake of these animals is very important and the placement and maintenance of an oesophagostomy tube should be considered in all cases until prehension and swallowing have been observed.

Mandibular symphysis separation can be repaired using nylon or polydioxanone to enable recreation of the fibrous joint. Thin orthopaedic wire can also be used for this purpose. Thick orthopaedic wire should not be used as it inevitably leads to bony symphyseal union which is undesirable. Traumatic cleft of the hard palate can be stabilised by a circumferential wire placed subcutaneously over the bridge of the nose and across the palate just caudal to the canines. The wires may be twisted together dorsal to the canine in the buccal vestibule to prevent trauma to the tongue (Figure 6.15).

Figure 6.12 The teeth extracted from the patient in Figure 6.11. Both teeth were loose in the mandible.

Figure 6.13 The patient in Figure 6.11. The tongue trauma could have been caused by the initial trauma or by the bur used to drill the hole through the jaw. It is important to protect soft tissues when using power-driven equipment.

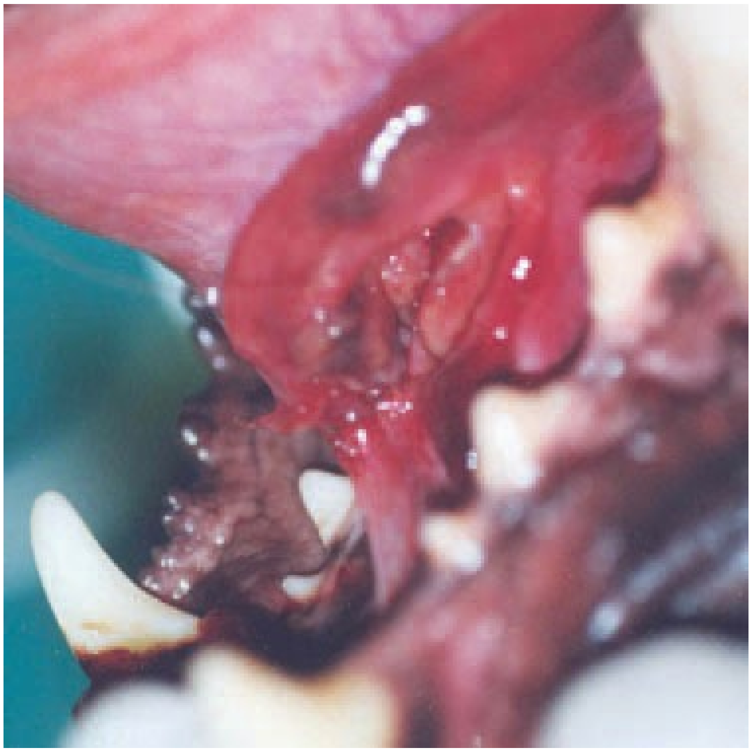

Figure 6.14 This dog was kicked in the mouth by a horse. The mandibular right canine was luxated (partially dislodged from its alveolus) and the tongue had been ripped from the sublingual tissues by the force. The tissues were thoroughly cleaned and sutured back in place. An uneventful recovery followed.

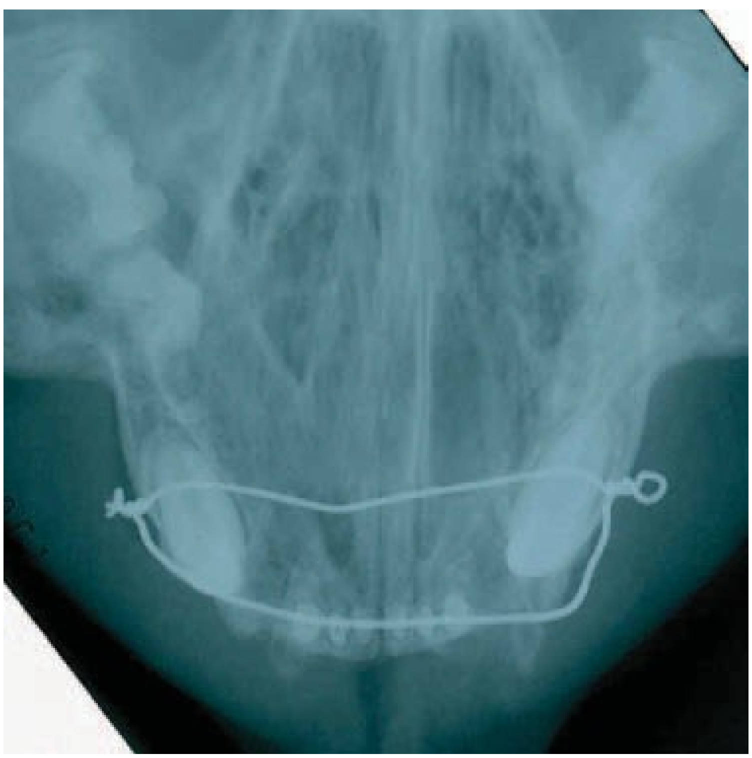

Figure 6.15 This patient was presented with a traumatic cleft palate which was about 10 mm wide. A 'circum-nasal' cerclage wire was placed subcutaneously, dorsally over the nose and orally across the palate caudal to the canines. The wire was twisted dorsal to the canine in the buccal vestibule on each side.

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7 Oral Surgery

Gingival overgrowth (hyperplasia) is more commonly seen in dogs than cats and some dog breeds are more predisposed to gingival hyperplasia than others (e.g. Boxer dogs). Gingival hyperplasia may affect one tooth or many teeth, and excised tissue should be submitted for histopathological examination to rule out neoplasia.

Hyperplastic gingiva should be recorded on the dental chart by drawing around and over the affected tooth. The extent is noted with dimensions measured using the periodontal probe. A pedunculated epulis is easier to excise, though some have a good blood supply requiring ligation (Figure 7.1). In some cases the gingival tissue is sessile and excision thereof can cause severe haemorrhage (Figure 7.2).

The depth of pseudopockets is measured (Figure 7.3), extrapolated against the buccal / lingual surface of the epulis (Figure 7.4) and marked by puncturing the gingiva using a dental explorer. The contour of the apical extent of the pseudopocket is depicted by bleeding spots. The hyperplastic tissue is excised by placing a scalpel blade against the gingiva just apical to the bleeding spots and making an incision which meets the tooth surface just coronal to the floor of the pseudopocket. This bevelled incision attempts to restore the gingival margin and contour, and obliterate the pseudopocket (Figure 7.5). It will be necessary to replace the scalpel blade often as it is soon blunted by the fibrous tissue. Bleeding may be profuse but can usually be controlled by digital pressure using a gloved finger or moistened gauze swabs. The use of dry swabs inevitably removes the newly formed blood clot, resulting in further bleeding.

Excised tissue must be submitted for histopathological examination to rule out neoplasia.

Figure 7.1 A large pedunculated epulis. These usually have a good blood supply which may require ligation at excision.

Figure 7.2 Sessile epulides can bleed profusely at excision but digital pressure is often sufficient to achieve haemostasis.

Figure 7.3 The pseudopocket formed by this epulis is measured using a periodontal probe.

The use of laser surgery has been described but there is insufficient scientific evidence to advocate the use of this treatment modality. Electrosurgical equipment should in the opinion of the author not be used in oral surgery as there is a danger of thermal-induced alveolar osteitis and pulpitis.

Figure 7.4 The depth of the pseudopocket is extrapolated buccally to determine the excision line. The apical extent of the pseudopocket is marked using a dental explorer to create a bleeding point.

Figure 7.5 An incision is made apical to the bleeding spots, eliminating the pseudopocket.

Oro–nasal communication – acute and chronic

Acute oro–nasal communications caused during extraction of a periodontally compromised tooth (Figure 7.6) or the iatrogenic penetration of the nasal cavity during tooth luxation or elevation are repaired by primary closure

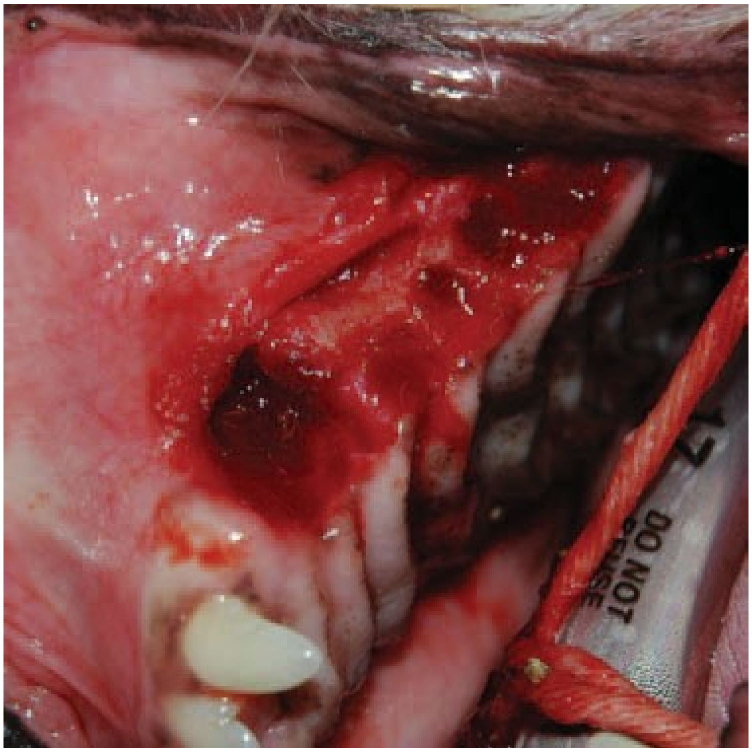

Figure 7.6 Acute oro–nasal communication can result during extraction of periodontally compromised teeth.

Figure 7.7 The oro–nasal communication in Figure 7.6 was closed by raising a mucoperiosteal flap. These lesions usually heal without complications. The client should be warned about the possibility of epistaxis following the surgery.

(Figure 7.7). If the site had a deep probing depth the walls of the pocket will have been epithelialised and this material must be debrided prior to closure. The margin of the pocket must also be debrided to remove compromised tissue which may cause repair failure. If there is no remaining attached

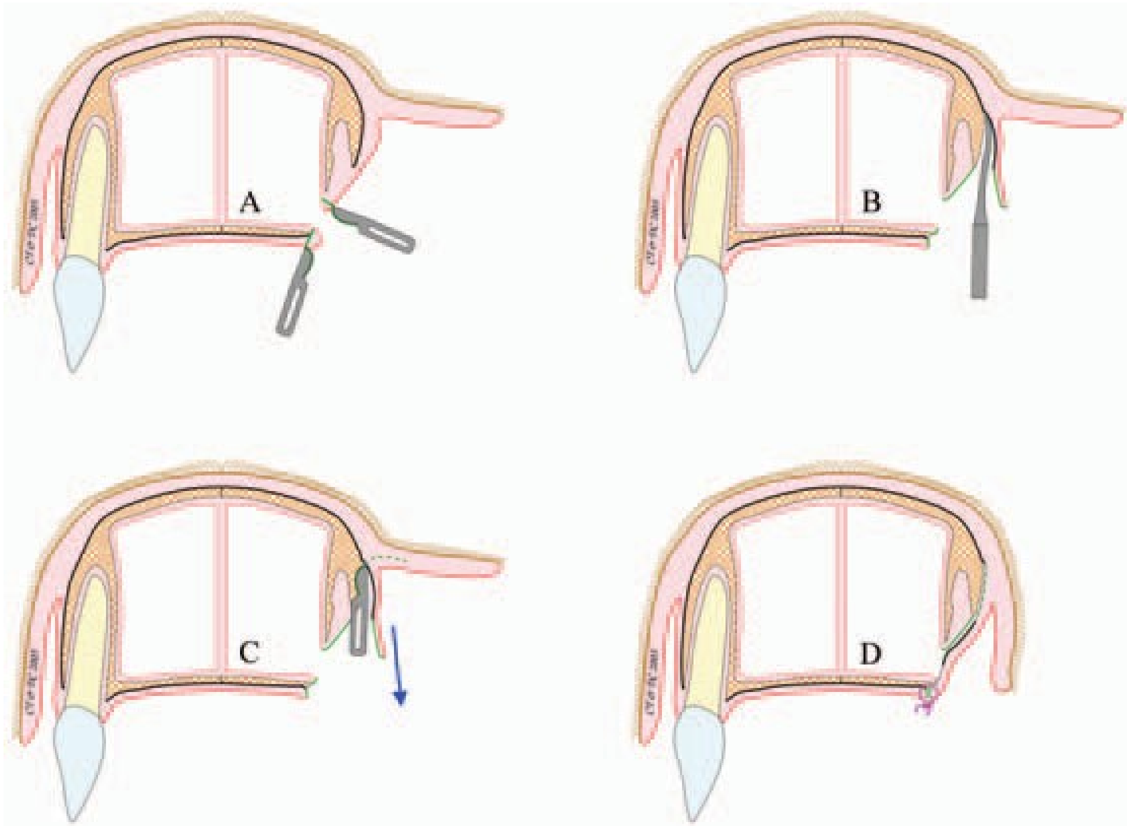

Figure 7.8 Single flap closure of an oro–nasal communication.
A: The edges of the defect are excised.
B: An alveolar mucoperiosteal flap is raised extending beyond the mucogingival line.
C: An incision is made through the periosteum at the base of the flap and it is extended as a split thickness flap. It is sometimes necessary to extend the flap into the buccal submucosa in order to obtain sufficient mobility to close the flap without tension.
D: The flap is advanced and sutured to the palatal side of the defect. Suturing is facilitated by raising the palatal mucosa from the bony palate using a periosteal elevator.

gingiva, a full thickness mucoperiosteal flap should be raised, extended as a split thickness mucosal flap and advanced to close the defect without tension. The leading edge of the flap may be rounded to fit the defect and will also ensure blood supply to the flap edge (square corners are sometimes compromised) (Figure 7.8). The flap must be sutured using synthetic, monofilament, absorbable suture material.

Cleft palate

The hard palate and its oral mucosa may be cleft following high-rise syndrome and other traumatic injuries. As long as the maxillae are stable and do not require surgical repair the palatal mucosa can be sutured using a simple, interrupted suture pattern to enable first intention healing (Figure 7.9).

Congenital cleft palate is seen in neonates from time to time and these patients should be referred to colleagues with experience in this treatment, as the first surgery undertaken usually has the best prognosis for complete repair.

Figure 7.9 The palatal mucosa was traumatically cleft in this cat. The oral cavity was flushed with chlorhexidine gluconate prior to surgery. Scale and polish (normally undertaken prior to oral surgery) was not done in this patient to prevent calculus from entering the nasal cavity. (This photograph kindly provided by Dr David Crossley.)

Chronic oro–nasal fistulae can be closed using a single advancement flap or double flaps. When using the double-flap technique the epithelial lining of the fistula should be debrided as above, except in the area where the first flap to be raised from the palatal mucosa will hinge. The first flap is carefully raised from the palate and hinged at the palatal margin of the defect. The flap is sutured into the defect with the oral mucosa now recreating the floor / wall of the nasal passage. A second flap is raised, beginning at the buccal margin of the defect, extending into the buccal mucosa so that it can be advanced to close the defect and the bed from where the first flap was harvested. This flap is sutured in such a way that it completely covers the first flap harvest site without tension (Figure 7.10).

It is important to remember when raising these flaps that the tissues are elastic and although they may fit the defect immediately after harvesting they will shrink slightly and cause extrinsic suture tension which may lead to dehiscence. When planning the flap, ensure that there is sufficient tissue to cover the defect with about half as much to spare. In other words, if the defect is 6 mm across, a flap will be needed which provides 9 mm of tissue to cover the defect prior to suturing. The natural post-harvest shrinkage should therefore not cause tension and dehiscence.

Periodontal surgery

In patients with deep periodontal pockets, pocket depth reduction techniques are used to maintain the affected teeth.

In some cases partial gingivectomy may achieve the desired effect with subgingival curettage and effective dental home care practised, to curb further

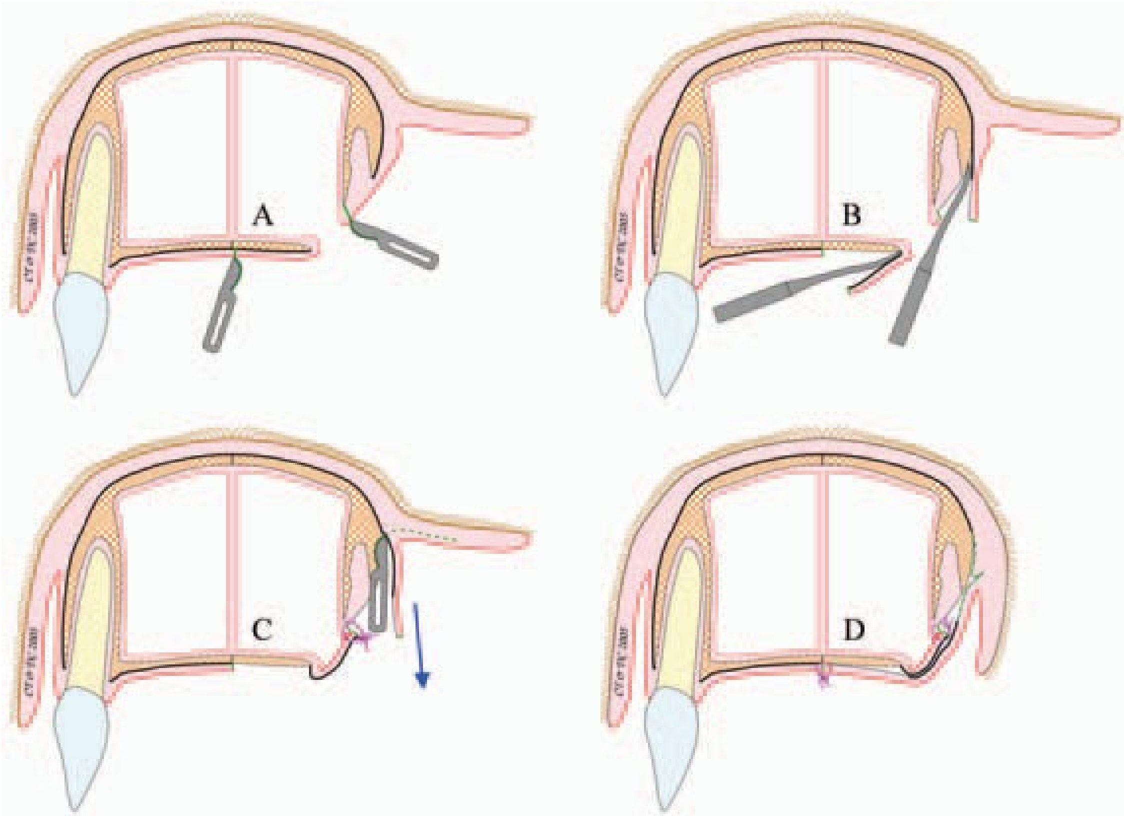

Figure 7.10 Double flap closure of oro–nasal defects.
A: An incision is made at the buccal margin of the defect to create the anchor point for the first flap. A second incision is made through the palatal mucosa at a distance from the palatal margin of the defect which will permit a flap to be raised which will reach the buccal anchor point.
B: Both flaps are raised as indicated.
C: The first flap (raised from the palate) is sutured without tension, using synthetic, monofilament absorbable suture material, to the buccal anchor point. The buccal flap is extended as described in Figure 7.8.
D: The buccal flap is sutured to the palatal mucosa covering the site where the first flap was harvested from.

deterioration. At least 2 mm of attached gingiva must be retained when performing this procedure.

In some patients it may be necessary to excise the inflamed gingival margin and raise a mucogingival flap, permitting open curettage of the tooth roots prior to the flap being sutured back in place (Figure 7.11).

Some patients are in the habit of chewing their sublingual tissues (tongue-biter syndrome) (Figures 7.12 and 7.13) and when severe, the lesions should be surgically excised. Care must be taken when planning excision of large lesions as they may be in close proximity to salivary structures (glands, ducts and puncta). Some patients bite their cheek mucosae, also leading to proliferative lesions (cheek-biter syndrome) (Figures 7.14 and 7.15). In severe cases surgery is needed to eliminate pain and bleeding due to trauma.

Mucoperiosteal flaps for surgical extraction techniques are described in Chapter 5 – Exodontics.

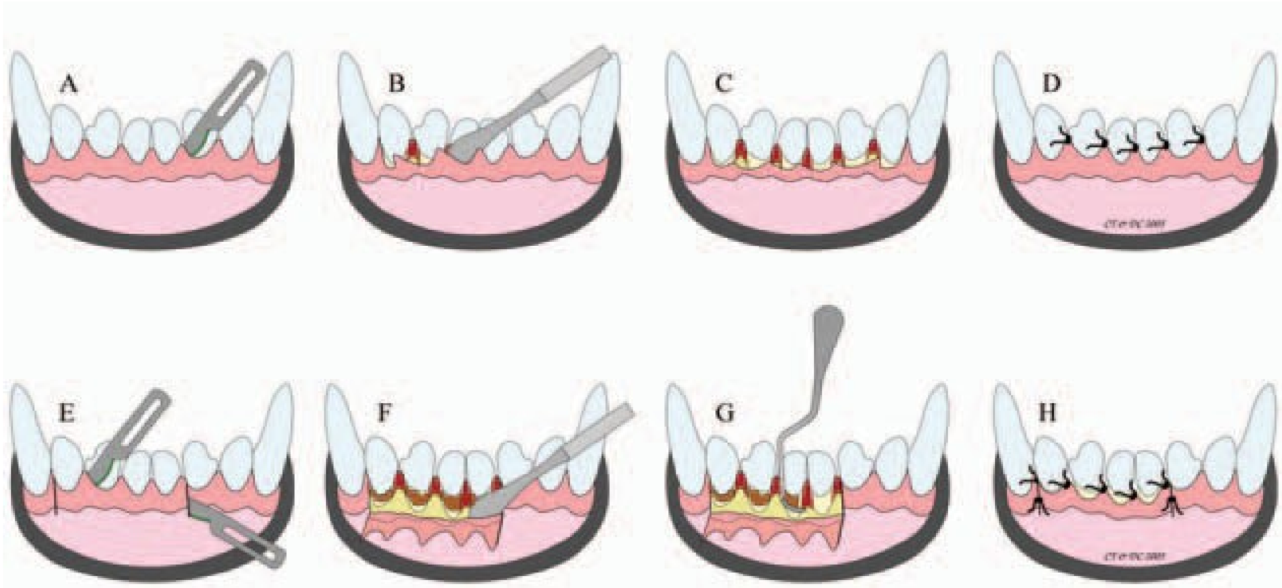

Figure 7.11 Periodontal surgery.
A: The inflamed gingiva is incised to the alveolar bone.
B: The attached gingiva is reflected from the alveolar bone using a periosteal elevator to create an envelope flap.
C: Subgingival 'open' curettage is performed.
D: The flap is sutured back in place using inter-dental sutures.
For deep pockets:
E: The gingiva is incised as in A above except that releasing incisions are made which cross the mucogingival line.
F: The flap is reflected to expose the apical extent of the pocket.
G: Open curettage is performed, including root debridement of necrotic cementum. Root debridement should be undertaken carefully to prevent denudation of the dentine.
H: The flap is sutured closed, in a slightly apical position, in an attempt to eliminate the pockets. Note that some cementum is exposed coronal to the gingiva.

Figure 7.12 Some animals chew their sublingual tissues (tongue-biters). This is a moderate form of the condition and does not require surgery. The inflammation is as a result of plaque on the adjacent teeth.

Figure 7.13 This is a very severe form of tongue-biter syndrome. The sublingual tissues have undergone severe proliferation. The lesion was bilateral in this dog and both lesions were excised. Histopathology revealed hyperplasia due to chronic mechanical trauma.

Figure 7.14 Some animals chew their cheek mucosa. This is a mild form of the condition.

Figure 7.15 This is a severe form of cheek-biter syndrome requiring surgical excision. These patients often bleed from the mouth after meals as a result of trauma to these lesions during eating.

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8 Suture Material

The most common cause of oral wound dehiscence is tension on the tissues. This tension may be intrinsic, caused by tying sutures too tightly, compromising the tissue within the suture or, extrinsic tension where there is tension on the wound edges because of insufficient tissue to close the defect (Figure 8.1).

The ideal suture material for use in oral surgery would:

- keep tissues apposed long enough to allow healing
- not cause inflammation
- not promote wicking
- not irritate the patient
- not require removal
- be strong enough to permit the finest material to be used.

The suture size chosen should be such that the strength of the suture material equals that of the tissue being sutured. These characteristics are not present in any one suture material so choice of material is based on the wound site, local conditions and surgeon's preference (Table 8.1).

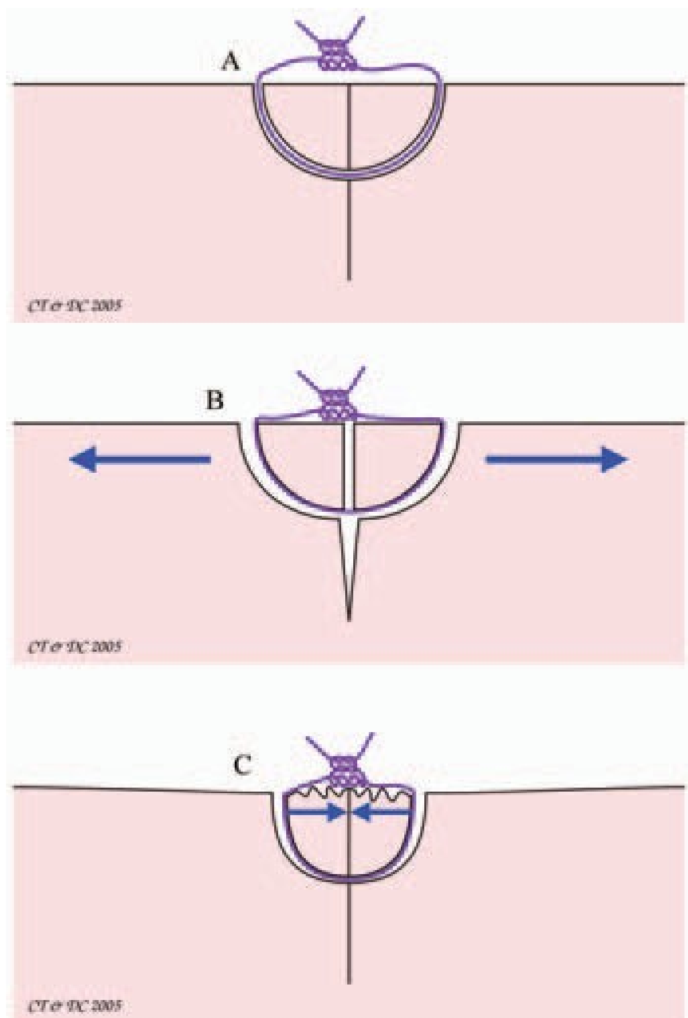

Figure 8.1 Suture tension.
A: Sutures should be tied so that the tissues are apposed but there is no extrinsic or intrinsic tension.
B: Extrinsic tension results from insufficient flap tissue to close the defect. This causes tension in the flap.
C: Intrinsic suture tension is caused by sutures which are tied too tight, thereby strangling the tissue within the suture.

Suture	Material origin	Material type	Filament	Absorbable	Means of absorption	Suitability for use in mouth	Loss of strength by (days)
Catgut	Natural	Collagen	Multifilament	Yes	Phagocytosis	Poor	21
Vicryl®	Synthetic	Polyglactin 910	Multifilament	Yes	Hydrolysis	Average to poor	42
Vicryl Rapide®	Synthetic	Polyglactin 910	Multifilament	Yes	Hydrolysis	Average to poor	14
PDS	Synthetic	Polydioxanone	Monofilament	Yes	Hydrolysis	Poor	>60
Monocryl®	Synthetic	Poliglecaprone	Monofilament	Yes	Hydrolysis	Good	21
Caprosyn®	Synthetic	Polyglytone 6211	Monofilament	Yes	Hydrolysis	Good	21
Nylon	Synthetic	Polyamide	Monofilament	No	Not	Very poor	>2 years

Table 8.1 Suitability of available suture materials for use in oral surgery.

Multifilament suture material is inclined to wicking which allows bacteria to migrate into deeper tissues. The use of multifilament suture material in the oral cavity is therefore undesirable because of the vast number of bacteria present in the mouth. The use of non-absorbable suture material in the mouth not only requires sedation or anaesthesia for removal but it can lead to severe trauma of the oral soft tissues, especially the sublingual mucosa.

Non-swaged-on suture needles should not be used in the mouth as they increase tissue drag and can cause tearing of the often compromised tissue to be sutured. A swaged-on reverse cutting needle is most preferable. Avoid round bodied or taper-cut needles as neither pass through the periosteum or gingiva with ease. When passing the needle through the oral tissues, care must be exercised not to engage the alveolar bone as this will severely blunt the needle making subsequent suturing difficult.

Suture material of 1 metric (5/0) size with a swaged-on reverse cutting 3/8 circle needle is ideal for most oral surgery, however under some circumstances this material is difficult to see and the use of magnification is desirable. Magnifying loupes are available in a number of formats; some with, and others without, accompanying illumination. Also, surgical or operating microscopes are becoming more affordable for use in general practice.

A reinforced surgeon's knot is required in oral surgery to ensure that the suture knot does not untie (Figure 8.2). Additional throws do not add to knot security but create a 'multifilament' bulky knot which may cause inflammation and provide a nidus of infection. By cutting the suture material too short knot integrity is compromised, however, ends which are too long will irritate the patient and may cause the patient to lick the knot loose prematurely.

Figure 8.2 The reinforced surgeon's knot is tied by throwing a double throw followed by a single throw and secured by a final single throw. The reinforced surgeon's knot should be used in oral surgery to prevent knots being licked loose.

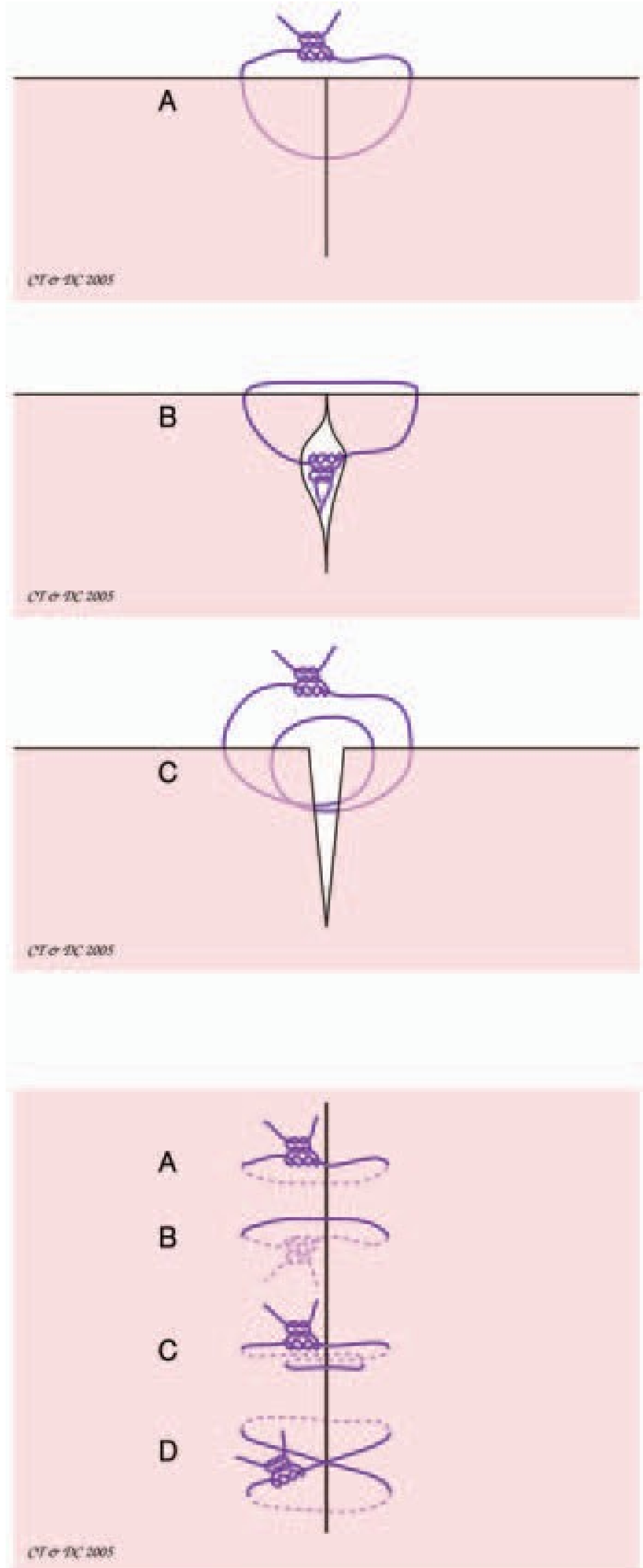

Figure 8.3 Suture patterns used commonly in oral surgery.
A: Simple interrupted pattern.
B: Simple interrupted pattern with a buried knot.
C: ‘Side view’: Far–near–near–far and crossed-mattress suture pattern.
C: ‘Top view’: Far–near–near–far pattern.
D: Crossed-mattress pattern.

Developing and using the 'buried knot technique' will minimise challenges to knot integrity (Figure 8.3). It is good practice not to take hold of the suture material which is to remain within the mouth with forceps, as this reduces the strength of the material. Clamping the knot to prevent slippage between throws is incorrect, not only because it damages the suture material, but also because this is an indication of extrinsic suture tension.

Suture patterns

The simple interrupted suture pattern is most often used in oral surgery (Figure 8.3A). The benefit of this pattern over the simple continuous pattern is that if the knot should come loose only one suture is compromised and not the whole wound edge. Using the buried knot technique, the first bite of tissue is taken deep in the incision and the needle brought out sub-mucosally. The second bite is taken sub-mucosally on the opposite side of the wound and the needle brought out deep in the incision. Both free and attached ends (needle end) of the suture material should be on the same side and a reinforced surgeon's knot is then tied at the deeper level. The suture material must be trimmed off at an appropriate length (Figure 8.3B). The suture can also be placed on the mucosal surface as illustrated in Figure 8.3B.

The far–near–near–far vertical mattress pattern can be used to appose and relieve tension on the wound edges concurrently (Figure 8.3C).

The crossed mattress interrupted suture pattern is also very useful as it is a tension-relieving suture pattern which will close twice as much wound edge as the simple interrupted pattern using a single reinforced surgeon's knot (Figure 8.3D). The buried knot technique can also be applied to this suture pattern but will require more practice to perfect. The suture is begun as a simple interrupted pattern but instead of the knot being tied after the first pass through each side of the wound, a second pass is made through each side (beginning on the initial side) and then the knot is tied. The loose end of the suture material must be passed through under the second loop of the pattern so that it ends up on the same side as the attached end enabling buried knotting to be performed.

Suture patterns which compromise blood supply to the wound edges (e.g. parallel mattress pattern) should be avoided in the mouth.

Where knots are placed on the surface they should all be to the same side of the wound and should not be placed directly over the wound edges. This will provide a straight wound edge. Placing knots on opposite sides of the incision line will cause a zigzag wound scar.

9 Restoration

Figure 9.1 Caries in the pit of the occlusal surface of maxillary right molar 1.

Figure 9.2 Enamel defects can cause irritation and trauma to overlying mucosa and should be smoothed off and varnished or sealed.

Tooth restoration is indicated where teeth are damaged either by trauma or decay (Figures 9.1–9.3) or developmental abnormalities (Figure 9.4) and where restoration to form and function is required following treatment, e.g. root canal therapy. Restorations should not be placed within 1 mm of the gingiva (this is known as the biological width) as doing so leads to gingivitis.

Figure 9.3 This dog has severe self-inflicted abrasion affecting the distal aspects of its canine teeth. These lesions are typical of dogs which 'cage-bite', also known as 'wire-biters'.

Figure 9.4 Enamel defects also expose dentinal tubules which may lead to pulpitis. This animal was affected by the Distemper Virus before it was three months old resulting in enamel dysplasia.

Under no circumstances should restorations be placed directly over exposed pulps of dog's and cat's teeth. This leads to pulp necrosis and root abscessation with oral or facial sinus tract formation (Figures 9.5–9.6). Pain associated with exposed pulps is evidenced in hindsight by the improvement in habitus after patients suffering from these conditions have been treated definitively.

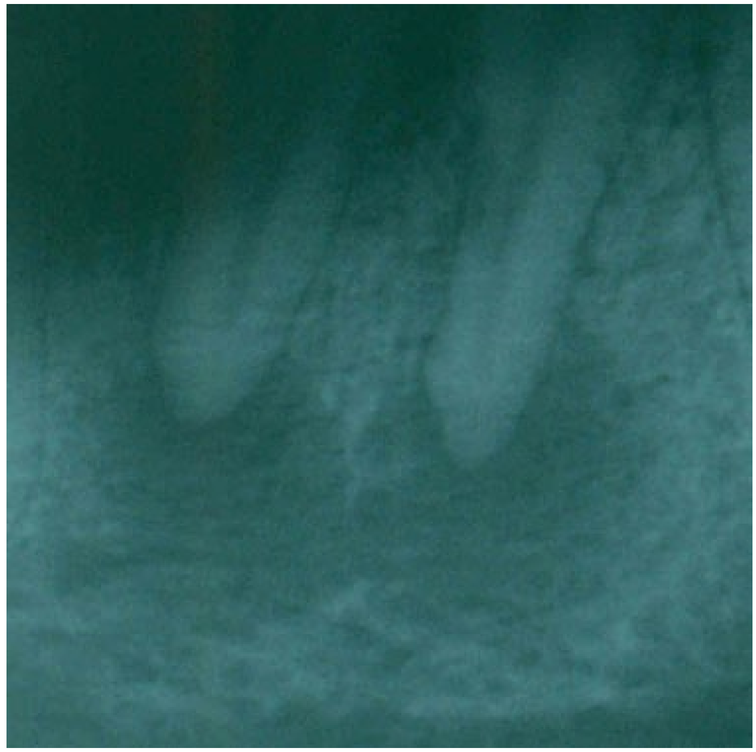

Figure 9.5 An inappropriately treated premolar in a dog. A restoration was placed directly over an exposed pulp, resulting in periapical abscesses. This tooth was later extracted because of the endo-perio lesion that had developed.

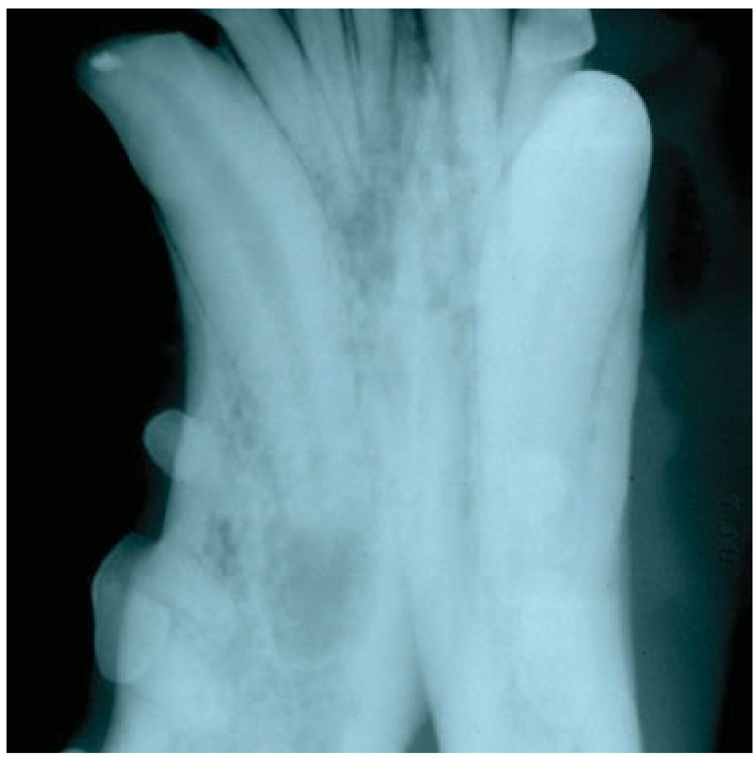

Figure 9.6 A restoration was placed over the exposed pulp of the mandibular right canine. Note the large periapical lesion as a result of pulp necrosis. The difference in width of the root canals of the canines is an indication that the pulp in the right canine tooth (left in this buccal view) became necrotic some time ago. Dentine formation has continued in the left canine. Root canal therapy was performed on the right canine tooth and the periapical lesion has since resolved.

Treatment of these cases requires endodontic therapy or extraction of the affected tooth.

The biting forces in dogs are greater than those experienced in man but the restorative materials used (almost exclusively designed for use in man) are often adequate.

Restorative material can be used on its own to restore tooth shape and height or it can be reinforced with small pins drilled into the dentine (known as para-pulpal pins). In some instances prosthetic crowns can be manufactured from aesthetic materials or metal alloys to resemble the original tooth crown.

The simplest form of restoration is the application of a varnish or sealant to a tooth crown following an uncomplicated crown fracture. The sharp edges of the crown can be smoothed using a fine diamond finishing bur or polishing stone. The dentine should then be sealed using a light or self-curing varnish. Exposed dentinal tubules often cause pain due either to exposed nerve fibres or changes in fluid pressure within the dentinal tubules leading to nerve stimulation. Sudden movement of fluid into or out of the dentinal tubule causes tension on the odontoblastic process resulting in severe pain. The dog in Figure 9.4 had Distemper Virus infection with resulting enamel dysplasia. The enamel of poor quality was gently removed using an ultrasonic scaler and the exposed dentine was sealed (Figure 9.7).

Figure 9.8 illustrates the step-by-step treatment of a tooth affected by caries.

When teeth are affected by caries (Figure 9.9) and intra-oral radiographs have shown that there is no pulp involvement or periapical pathology, the carious material should be debrided (Figure 9.10) and a restoration placed (Figure 9.11). It is often necessary to line the prepared cavity with a lining material to 'medicate' the pulp. These materials protect the pulp from the restorative materials, some of which have been shown to cause pulp inflammation. A permanent restoration is then placed, ensuring a good coronal seal which prevents communication between the dentine (and pulp) and the oral cavity.

Figure 9.7 Teeth of the dog in Figure 9.4 after debridement of dysplastic enamel and sealing of the exposed dentine.

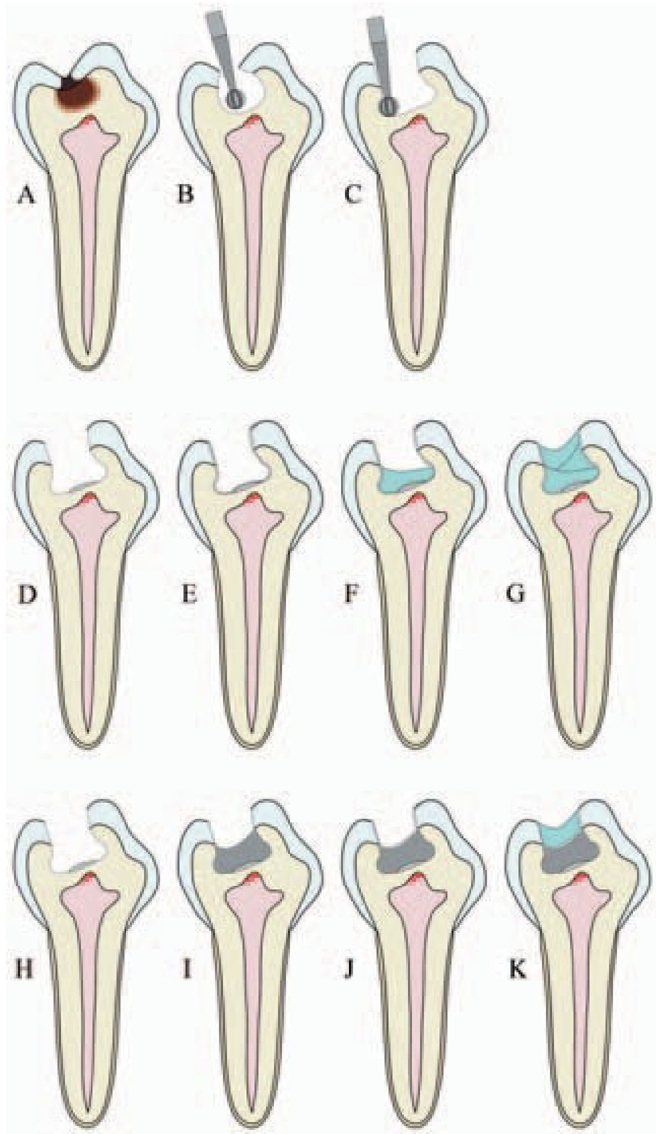

Figure 9.8 Restoration of caries.
A: Caries lesion in a tooth.
B: A high-speed water-cooled bur is used to remove enamel to expose the caries in the dentine. A slow-speed bur (and spoon excavator) is used to debride the caries-affected dentine, taking care not to expose the pulp.
C: An undercut is made in the wall of the prepared cavity ensuring that the enamel is not undermined and that the structure of the tooth is not compromised.
D: A 'pulp dressing', usually calcium hydroxide paste, is applied to the floor of the cavity to protect the pulp from the restorative material. This is especially important if the dentine covering the pulp is very thin (<1 mm).
E: If composite or compomer restorative material is to be used, a bonding agent is applied to the cavity after it has been conditioned / etched (depending upon manufacturer's instructions).
F: Light-cured restorative materials should be placed and cured incrementally, as the curing light does not penetrate thick material.
G: The final restoration should be polished and varnished to protect it from desiccation and moisture.
H: Glass ionomer restorative may be used as the initial layer. In this case bonding agent is not required as the ionomer forms a chemical bond with the tooth substance.
I: When the glass ionomer layer has been applied and cured, the exposed dentine and enamel should be conditioned / etched as in E.
J: The bonding agent applied should be applied as in E.
K: The final restoration is applied and cured, polished and sealed as in G.

Figure 9.9 The caries lesion in Figure 9.1 has been exposed by removing enamel using a high-speed bur.

Figure 9.10 The caries has been debrided using a slow-speed bur and a small spoon excavator.

When amalgam (silver, mercury and copper alloy) was used routinely in veterinary dentistry it was necessary to prepare the cavity in such a way that the walls of the cavity converged coronally (known as an undercut) to ensure that the restoration was held in place physically (physical retention). The amalgam

Figure 9.11 The final compomer restoration has been cured and varnished with an unfilled resin. A lighter coloured restoration than the tooth was chosen so that it is not damaged by excessive scaling at the next prophy treatment.

was polished and this created a coronal seal which improved as the amalgam underwent some 'corrosion', the products of which filled the potential space between the restoration and the surface enamel. Modern amalgams are now placed onto a bonding material which helps keep the restoration in place and improves the coronal seal, negating the need for undercuts in the cavity preparation. Amalgam is rarely used in domestic pets these days.

With the advent of modern (mostly non-metallic) restorative materials it is no longer necessary to create undercuts as the materials either bond directly (via chemical bonds) to the tooth substance, or a bonding agent is first applied to the tooth and the restorative material is in turn bonded to the bonding agent in a sandwich technique. A micro-mechanical bond is created when the enamel is etched and dentine conditioned. Etching and conditioning effectively 'roughens' the surface of these tissues allowing the bonding material to 'interlock' with the tooth substance. Both light and chemical-cured (self-cured) materials are used.

Etching is performed by applying 37–40% phosphoric acid gel to the enamel surface for 10–15 seconds to demineralise the enamel and thereby increase the surface area to which bonding agents are applied. A conditioner is used to create similar conditions on dentine. These materials must be thoroughly rinsed off and the tooth surface must then be partially dried depending upon which restorative technique is to be implemented. Desiccation of the tooth surface following etching and conditioning is detrimental.

Glass ionomer restorative materials bond directly with the tooth substance via chemical bonds. A bonding agent is therefore not required when using these restoratives. Once placed and cured, glass ionomer restorations should be sealed using a varnish to prevent desiccation or imbibition of moisture, as this can affect the longevity of the restoration.

Figure 9.12 This dog underwent crown amputation and partial pulpectomy and restoration, as treatment for mandibular canine malocclusion. At the three-month check-up the restoration was secure and a dentinal bridge had formed. At about six months post treatment the client reported that the tooth had become discoloured. As seen in this photograph, the restoration in the mandibular left canine had been intruded, disrupting the coronal seal (compare with mandibular right canine treated at the same time). When questioned about the dog's behaviour the client reported that it insisted on biting hard objects. An intra-oral radiograph revealed a periapical radiolucency involving the mandibular left canine. The pulp was necrotic and root canal therapy was therefore performed.

Composites are restorations comprising particles and resin which require a bonding agent to sandwich them to the tooth surface.

Compomers are hybrids between composites and glass ionomers often used in veterinary dentistry as they provide restorations which appear to withstand normal chewing behaviour in our patients.

Although, as mentioned above, it is not necessary to create undercuts to retain modern restorations, an undercut at the depth of the cavity preparation is desirable to aid in restorative retention in hard biting patients (Figure 9.12). Care must be exercised when making these undercuts to ensure that they do not undermine the enamel or unduly weaken the tooth. Ideally, the floor of the cavity should be flat and the junction with the walls curved so as to prevent trapping of air within or under the restoration. The enamel surface should be tapered slightly to increase the surface area to which bonding occurs.

Restorations should be polished smooth. A varnish can also be applied to improve surface smoothness as it makes the restorative surface less plaque retentive, thereby reducing gingival inflammation.

Light cured restorative materials polymerise as a result of initiation by a light source of specific wavelength. The curing light cannot penetrate beyond about 2 mm and therefore these restorations must be placed and cured incrementally (i.e. in layers) (Figure 9.8 F). This not only creates a thoroughly cured restoration but also reduces post-curing dimensional changes such as restorative shrinkage. The advantage of light-cured restorations is that they can be placed and shaped prior to initiation of polymerisation. The use of a cellophane strip against the restorative surface will lead to an extremely smooth restoration which may not require polishing.

The endotracheal (ET) tube must be removed to check occlusion and necessary adjustments made prior to the patient being woken. Six-monthly checks

should be performed at which intra-oral radiographs may be taken under sedation to ensure that the pulp is still vital. Where evidence of pulp necrosis is present the patient should be referred to a colleague able to perform root canal therapy.

The client should be warned that treatment failure may present as tooth discolouration or a draining sinus either into the oral cavity or onto the face / chin and that immediate treatment will be necessary.

In some patients that chew hard objects the restoration may become dislodged therefore the client must be advised to prevent the animal from chewing these objects. Regular examination by the client will pick up changes to the restoration in good time.

When required, prosthetic crowns may be manufactured to place on teeth which have been fractured. The client must be warned about failure of these prostheses since hard biting dogs can dislodge the crown soon after placement, or they may fracture the tooth again apical to the crown necessitating extraction.

Further reading

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Kidd, E.A.M. and Smith, B.G.N. (1998) *Pickard's Manual of Operative Dentistry* (7th edn). Oxford Medical Publications, Oxford.

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Small Animal Dentistry: A Manual of Techniques
Cedric Tutt

10 Endodontic Therapy

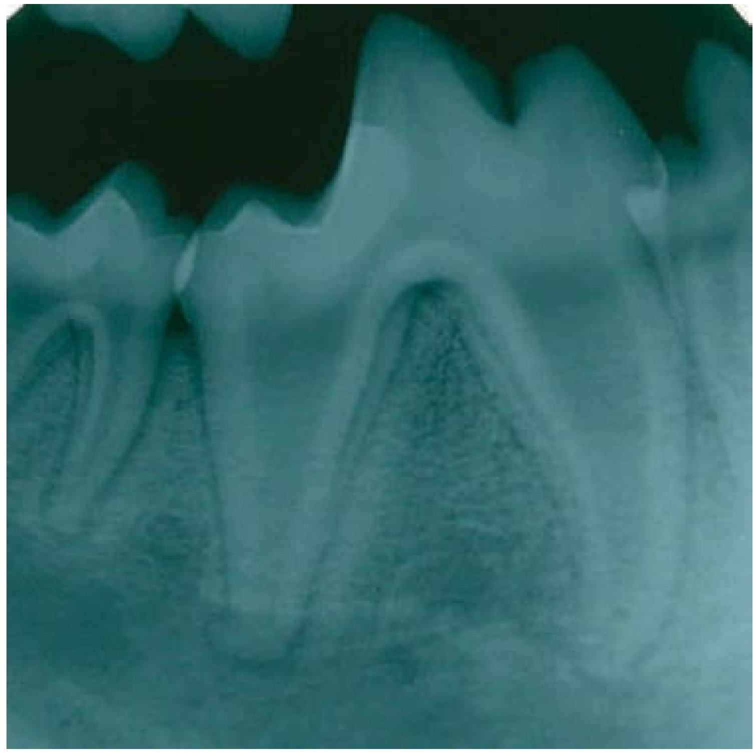

Figure 10.1 Mandibular molar radiograph showing pulp horns, pulp chamber and root canal.

Endodontic therapy is the treatment of the endodontic system and for the purposes of this text a brief outline of partial and complete pulpectomy, root canal therapy and endodontic access restoration will be given. These procedures are usually undertaken by colleagues who have the necessary equipment, practical knowledge and expertise to perform specialised veterinary dental procedures.

The endodontic system includes the pulp chamber and pulp canal or root canal. Both structures are continuous and in multi-rooted teeth there are projections of pulp into each cusp known as pulp horns (Figure 10.1). These structures are developed to a greater or lesser extent depending upon the tooth, e.g. the pulp horns in the crown of the mandibular molar 1 tooth are well developed and it is via these that the pulp chamber may become exposed in a complicated crown fracture.

The pulp consists of blood and lymph vessels, nerves, odontoblasts, fibroblasts and other undifferentiated mesenchymal cells. The pulp communicates with the periodontal tissues via the apical delta and accessory or lateral canals.

The pulp may become inflamed for a number of reasons including: blunt trauma to the tooth, uncomplicated and complicated tooth fracture, enamel and dentine hypoplasia / dysplasia, via the haematogenous route and iatrogenic causes, including inappropriate use of polishing devices, electromechanical scalers, restorative materials and placement of dental acrylic during orthodontics or inter-dental splinting. Playing with tug toys has also been shown to cause reversible pulpitis. Pulpitis inevitably leads to pulp necrosis and periapical pathology which may extend to involve the periodontium and sometimes erupt through the skin of the face or chin or into the mouth. Incarceration of the coronal pulp due to pulp canal stenosis leads to ischaemia and necrosis of the coronal pulp (Figure 10.2). This is usually evidenced by sudden changes in tooth colour. In these cases the apical part of the pulp is

Figure 10.2 The crown of this maxillary right lateral incisor became acutely discoloured – an indication of pulpitis / pulp necrosis.

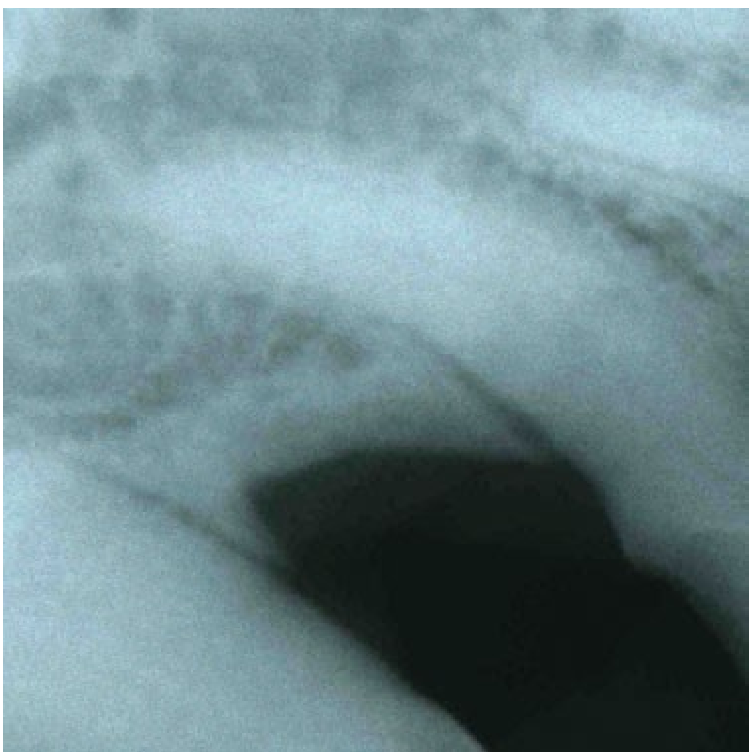

Figure 10.3 Survey radiograph of the tooth in Figure 10.2. Note that there is no periapical pathology indicating that the apical pulp is still viable.

inaccessible and periapical radiographs usually reveal intact periapical tissues, an indication that the apical pulp is still viable (Figure 10.3). Endodontic treatment of the coronal part of the tooth is required and the apical pulp must be monitored by regular periapical radiographic evaluation (Figures 10.4 and 10.5).

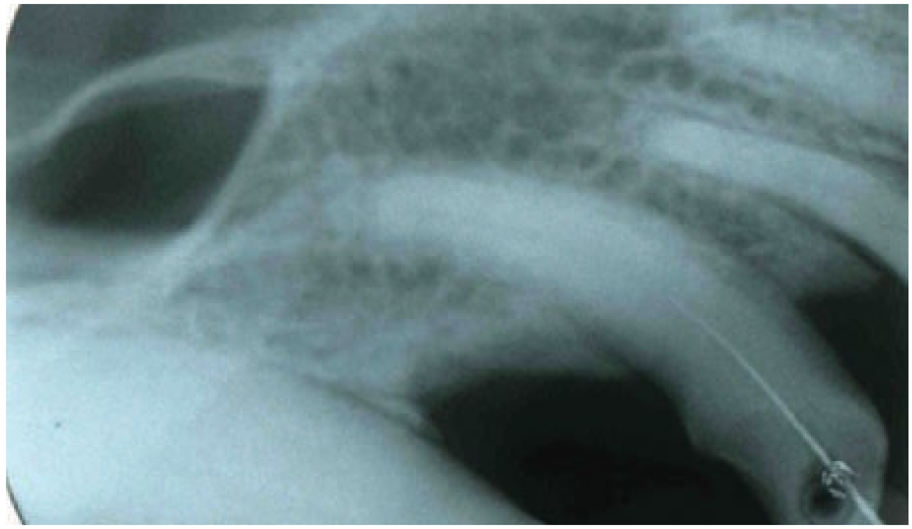

Figure 10.4 Working length is determined by inserting a fine endodontic file until a firm stop is felt. This should only be done after the presence of an apex is confirmed or the file may be inserted through an open apex. In this case there is canal stenosis just below the alveolar margin.

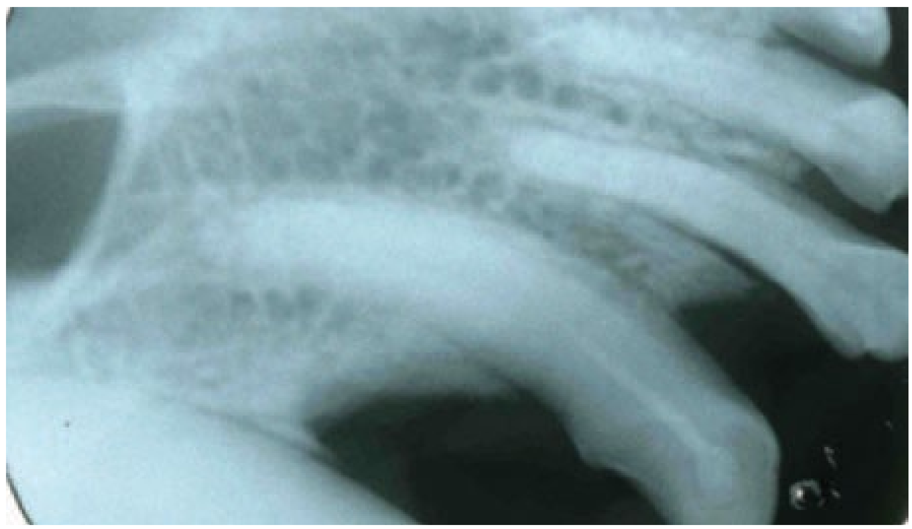

Figure 10.5 Post-treatment radiograph showing the root canal treatment. Follow-up radiographs should be repeated at three and six months post treatment.

Partial pulpectomy

Partial pulpectomy and restoration should not be undertaken by inexperienced clinicians as the procedure has been known to fail even in the hands of experienced veterinary dentists. It must also be stated that partial pulpectomy is an inappropriate procedure in patients with mature teeth (apexogenesis is complete). Exceptions to this rule are where the procedure is performed as a temporary measure in the treatment of jaw fracture repairs or in geriatric patients where prolonged anaesthesia is undesirable. If the patient has mature teeth (apexogenesis is complete) the procedure of choice is complete pulpectomy followed by root canal therapy. Apexogenesis is the normal formation of the apical delta. When apexogenesis is complete the root will have attained its final length.

Periodically, the clinician may elect to perform crown shortening procedures in the treatment of patients with malocclusions. During this procedure the crown of the tooth is amputated at the desired height (usually to the height of the adjacent lateral incisor) and a partial pulpectomy is performed where

Figure 10.6 Radiograph showing the final restoration and calcium hydroxide dressing in a dog on which both mandibular canines underwent crown amputation, partial pulpectomy and restoration.

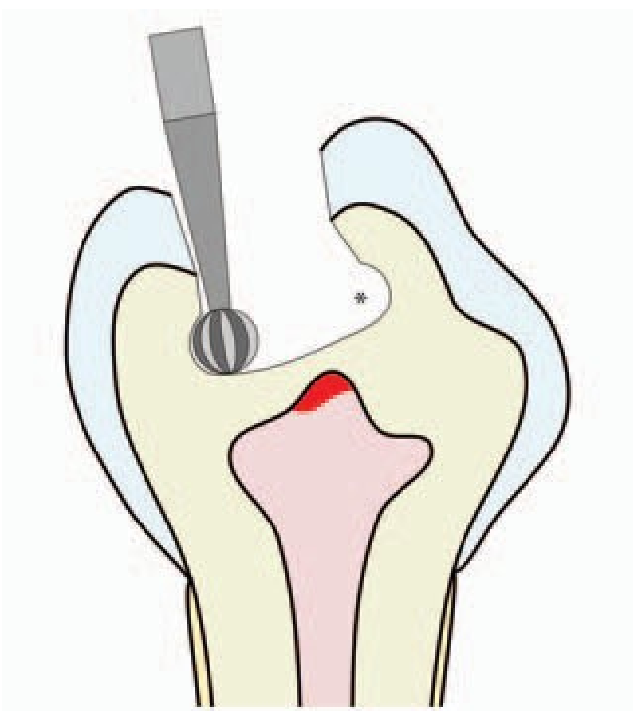

Figure 10.7 Illustrating the creation of an undercut (*) in the dentine during the preparation of a cavity prior to restoration.

about 5 or 6 mm of pulp is resected using a new, *sterile*, sharp, round diamond bur. Once haemostasis is attained a calcium hydroxide dressing is very gently placed onto the pulp without it being forced into the pulp. A calcium hydroxide base / liner is applied before the access site is restored using the clinician's restorative material/s of choice (Figure 10.6). When preparing the cavity for restoration a small undercut (Figure 10.7) should be created to 'key' the

restoration into the dentine. Some dogs that are in the habit of chewing hard substances have been known to dislodge restorations inwardly (apically) resulting in treatment failure. It bears mentioning that the pulp cavity is almost conical at this point, with the base being apical. 'Keying' the restoration in gives added security to the restoration.

The calcium hydroxide dressing dissociates and stimulates odontoblasts to produce a dentinal bridge which will separate the pulp from the restoration. Calcium hydroxide dressing material which has been inappropriately stored (i.e. exposed to light, heat and air) will undergo a chemical change to calcium carbonate which will not stimulate the production of the dentinal bridge and the procedure will fail. Mineral trioxide aggregate (MTA) has been used in place of calcium hydroxide in the treatment of pulpectomy with good results. In these patients the dentinal bridge has been found to be confluent with secondary dentine in the area.

The teeth of patients who have undergone partial pulpectomy must be re-evaluated radiographically on a regular basis (three-month intervals) to determine the success of the procedure. Failed procedures may require repeat treatment or apexification treatment (treatment of an immature tooth with pulp necrosis in an attempt to induce delta formation, the discussion of which is beyond the scope of this text).

Successful treatment is recognised by the development of a dentinal bridge (seen as a distinct band of increased radiodensity apical to the restoration) and completed apexogenesis (Figure 10.8). The dentinal bridge, like all dentine, is porous and therefore if the restoration becomes dislodged or shows signs of marginal leakage it must be replaced immediately or the pulp may become inflamed and necrotic. A void usually develops between the restoration and the dentinal bridge (the space originally occupied by the calcium hydroxide) and it might therefore be good practice to remove the restoration and replace it with a base liner and permanent restoration as soon as the dentinal bridge has formed and is visible radiographically.

Some veterinary dentists are of the opinion that partial pulpectomy and restoration are temporary measures to enable apexogenesis and that once this has happened the restoration should be removed and the tooth subjected to complete root canal therapy. Others, however, believe that treated teeth should be monitored on a regular basis and that endodontic therapy should only be performed when indicated.

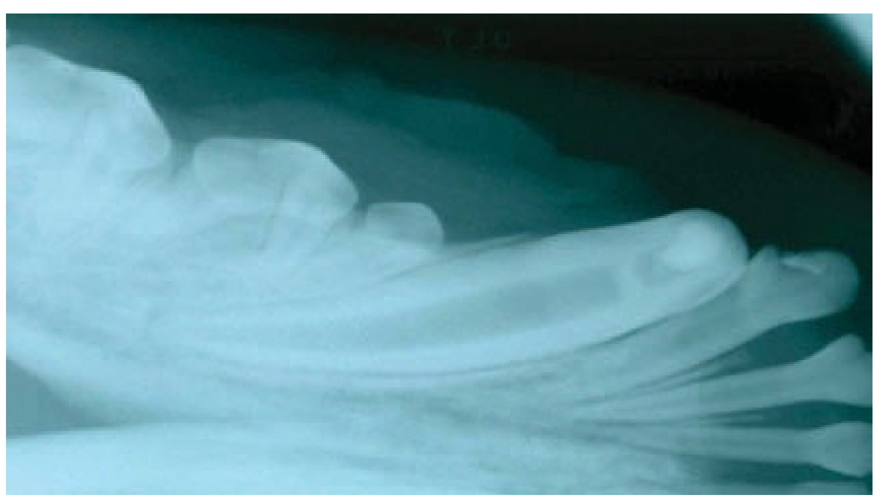

Figure 10.8 A successful treatment outcome is confirmed by complete apexogenesis and a dentinal bridge apical to the restoration.

Root canal therapy

Steps in root canal therapy

- create access to the pulp chamber / root canal. This may be via the complicated crown fracture site or at the crown amputation site
- extirpate the pulp using barbed broaches and Hedstrom files
- gently insert the smallest file until it reaches a solid stop. Determine the working length radiographically; measure and mark all files
- shape and debride the root canal by sequential filing (beginning with the smallest diameter file and working up to the master file)
- flush the canal after each filing episode with copious volumes of sodium hypochlorite solution (5% solution at about 60 °C)
- when the next file size up does not go all the way to the apex when inserted into the canal it should be gently worked to the apex and becomes known as the master file
- flush repeatedly using sodium hypochlorite. Finally, rinse using sterile water
- dry the canal using paper points
- insert the master cone (gutta percha (GP) point of equivalent size to master file) and radiograph to confirm seating at apical extent of root canal
- remove cone and apply root canal sealant to walls of canal
- reseat master cone, driving it to the apex using a condenser if needed (vertical condensation)
- accessory cones should be packed around the master cone until the canal is completely obturated (filled in its entirety). A spreader can be used to create space for additional accessory points
- when the root canal procedure is completed, obturation is confirmed radiographically, excess gutta percha is trimmed and a base liner applied
- final restoration placed using the clinician's restorative materials of choice as indicated for this procedure
- final radiograph taken to confirm complete apical and coronal seals
- follow-up radiographs are scheduled six monthly.

Root canal therapy procedure

This procedure requires extirpation of the pulp and obturation of the pulp system using an inert substance and final restoration.

Once access to the pulp system has been gained, the pulp is removed using a combination of root canal files and barbed broaches. In some instances a second access is created to facilitate a straight line access to the root apex, requiring an access hole to be burred into the pulp canal about 2 mm coronal to the gingiva. Once the pulp is removed, the walls of the root canal and pulp chamber are debrided and shaped to accommodate an inert filling material, usually GP points (made of rubber) and a sealant paste. Once obturation is completed the access site/s are restored.

Figure 10.9 A set of Hedstrom files ranging from ISO 15–80, each with a silicone 'end stop' used to mark working length on the file.

Two commonly used root canal filing instruments are:

(1) Kerr files manufactured from a triangular or rectangular tapered rod which is twisted to create flutes. These instruments operate in a watch-winding fashion, a reciprocating motion created by rolling the instrument handle clockwise and anti-clockwise between the thumb and forefinger.

(2) Hedstrom files are machined from a conical blank with the cutting edge of the file facing up the shaft. These files have their effect on the pull stroke and are inserted into the canal and pulled out to clean and shape the walls. The pulling action shaves material off the canal walls cleaning and shaping the canal.

Files are manufactured in a number of lengths 25–31 mm are adequate for most dog incisors and premolars and cat teeth; 55–60 mm files are used for canine teeth. Files come in standard sizes from ISO 8 to 130. A file with an ISO size of 25 will have a tip diameter of 0.25 mm (Figure 10.9).

The working length is determined by introducing a file into the root canal and taking a periapical radiograph confirming that the file tip is at the apical extremity of the root canal. Once the working length is determined, all files are measured and marked accordingly (Figure 10.10) and the canal instrumented (debrided and shaped) using sequentially larger files until the file, which is the next size up, does not go all the way to the measured working length when inserted into the canal. This file should be gently worked down until it reaches the working length, it then becomes known as the master file. By this time all dentinal shavings produced by the files should be clean, i.e. white or ivory instead of grey / black.

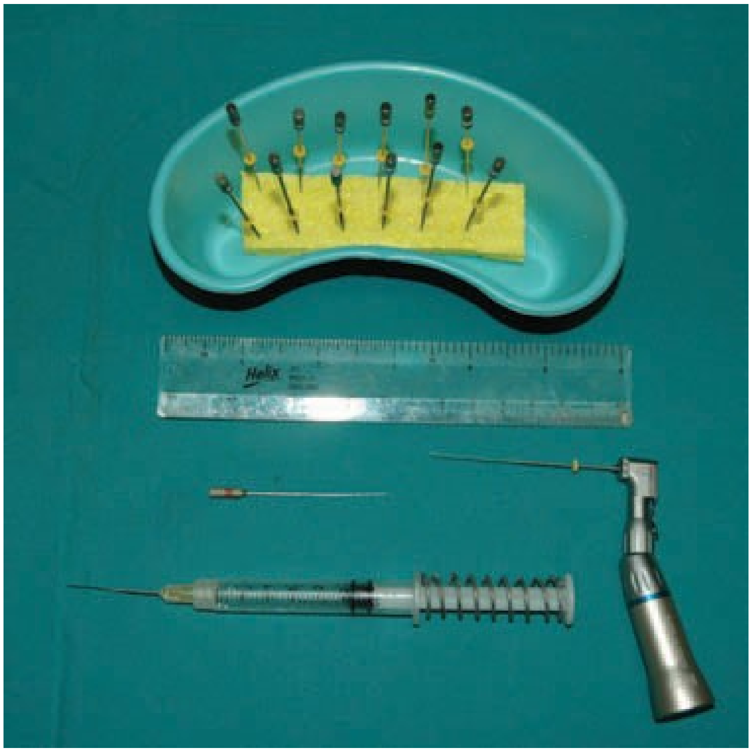

Figure 10.10 Endodontic files with 'end stop' markers in place. A ruler is used to measure the files to working length. A barbed broach is used to remove the pulp. Endodontic flushing needles are used to flush the canal between filing episodes. A Lentulo spiral paste filler is used to deliver calcium hydroxide paste into the canal, ensuring it is delivered to the apex.

The pulp chamber and root canal must be flushed with copious volumes of sodium hypochlorite (approximately 5% solution preferably at 60 °C) ensuring that surrounding soft tissues are protected from this substance. Flushing should be performed following each filing episode to remove debris and necrotic material, and to disinfect the canal. The hypochlorite also acts as a filing lubricant. Thicker files can compact dentinal debris into the apical part of the canal and therefore it is necessary to recapitulate (revert to a smaller sized file) regularly to remove filing debris from the apical part of the canal.

Under ideal circumstances the canal will have been filed to a tapered void with its base at the pulp chamber and its apex corresponding with the apical extent of the root canal. The canal should be flushed a few more times using sodium hypochlorite and then rinsed thoroughly using sterile water. Following rinsing, the canal should be dried using paper points. Some manufacturers produce ISO dimension paper points that fit the canal debrided by a correspondingly sized master file (Figure 10.11). Some paper points are supplied sterile but once the pack is opened they are no longer sterile.

Once debridement and shaping are completed, the master point (the GP point corresponding in size to the master file (Figure 10.12)) is selected and placed into the canal. A radiograph is taken to ensure that the cone is seated all the way to the apical extremity of the root canal. When this has been confirmed, the GP point is removed, root canal sealant is applied to the walls of the canal and the master cone is inserted all the way to the apex. A condenser (fine instrument used to pack GP points into the canal) may be required to drive the master cone into the apex (vertical condensation). If there are voids surrounding the master cone coronally a spreader may be inserted to condense the master cone laterally, creating space for accessory cones to be

Figure 10.11 Paper points are manufactured in fine, medium and coarse or according to ISO dimensions.

Figure 10.12 Gutta percha (GP) points are made in human and veterinary length. In this case the files are human length and range from ISO 15–140.

inserted until the whole canal is obturated (completely filled). After radiographic confirmation that obturation is complete, excess gutta percha is trimmed and a base liner is applied over the gutta percha prior to placement of the final restoration (See Chapter 9 – Restoration). If a second access site has been created it must be restored in the same way as previously described. A final radiograph should be taken to confirm good coronal and apical seals (Figures 10.13–10.16).

Follow-up radiographs should be taken six months following the procedure. Currently, root canal therapy is judged as being successful if new bone has filled the periapical defect around the apex of the root. Histological confirmation of success is obviously not possible in the living patient!

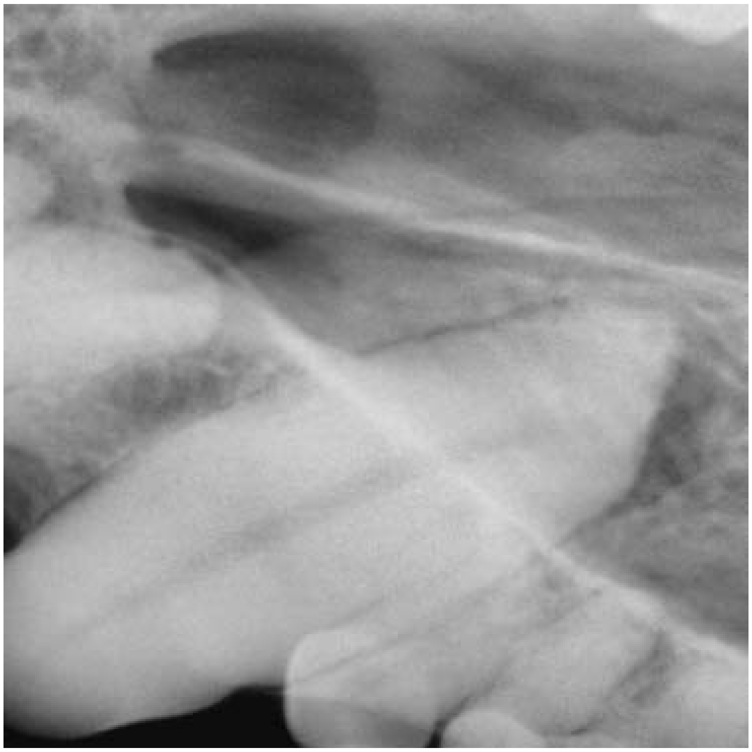

Figure 10.13 Survey radiograph of a tooth on which root canal therapy is to be performed is essential, as subgingival fractures may be present. Note the external root resorption at the apex of this tooth. This is often caused by periapical inflammation as a result of pulp necrosis.

Figure 10.14 Working length is determined by inserting a fine endodontic file until a stop is reached. In this tooth with a wide pulp canal a larger-sized file was used to determine working length.

Motorised endodontics

Also known as engine-driven endodontics, this technology makes use of an electric motor which drives endodontic files. The crown-down technique is used, where the coronal part of the pulp cavity is instrumented initially and

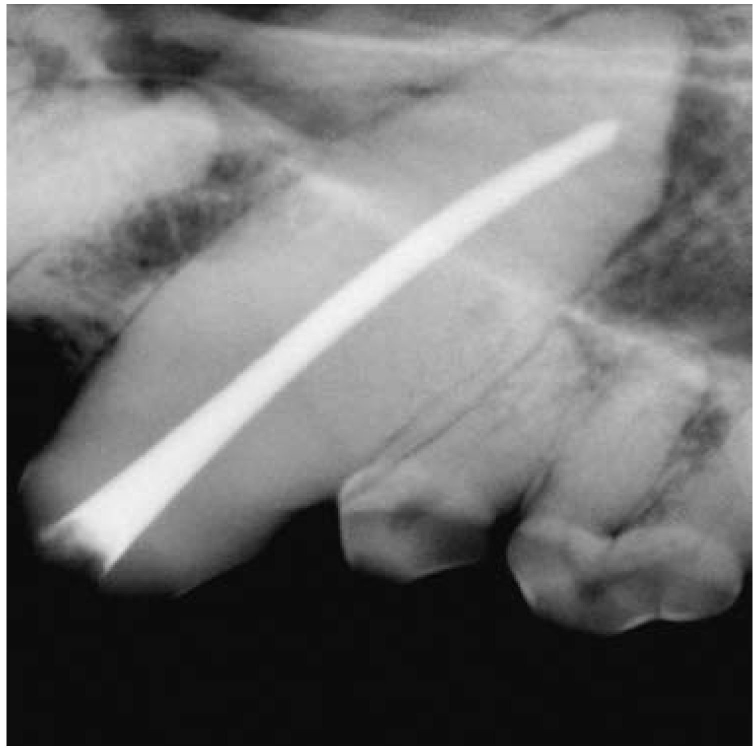

Figure 10.15 Obturation is complete with a good apical fill.

Figure 10.16 Final restoration showing a good coronal seal. The slightly radiolucent area between the root-filling material and the coronal restoration is glass ionomer which is not radiodense.

then sequentially filed and shaped to the apical extremity. This technique creates a cavity / canal which is tapered from the crown to the apex enabling more efficient flushing with less likelihood of material being flushed through the apical delta. Obturation is also improved with GP points available to fit the prepared canal.

Some electric motors are equipped with a torque system which stops the motor once excessive friction is encountered and reverses the endodontic file momentarily before continuing. This reduces the likelihood of instrument separation (breakage).

Ultrasonic endodontics

Some ultrasonic dental scaler units have specially designed endodontic tips used to debride and shape canals. An advantage of these systems is that the flushing fluid is delivered through the tip ensuring that the entire canal is flushed continuously during instrumentation.

Thermoplastic obturation

Numerous 'heated' gutta percha systems are available. Some heat the gutta percha in a syringe and the canal is subsequently filled with molten material. Others systems have gutta percha applied to introducers manufactured to ISO dimensions and heated in specially designed ovens. Once the material has been heated for the appropriate length of time the gutta percha is placed in the canal using the introducer which remains *in situ*. Excess material is trimmed off prior to the final restoration being placed.

Some interesting cases

The cat in Figure 10.17 was involved in a road traffic accident and sustained fractures to both maxillary canines. Although these teeth are good candidates for endodontic therapy, a pre-treatment radiograph revealed that one of the

Figure 10.17 This cat sustained canine fractures as a result of a road traffic accident. Pre-treatment radiographs revealed that one canine had a second fracture in the coronal third of the root, necessitating extraction. The other canine underwent root canal therapy.

canines had a transverse fracture in the coronal third of the root necessitating extraction. Discoloured teeth (Figure 10.18) should be examined radiographically as pulpitis / pulp necrosis is often associated with periapical pathology. The procedure carried out in Figure 10.19 revealed that the pulp

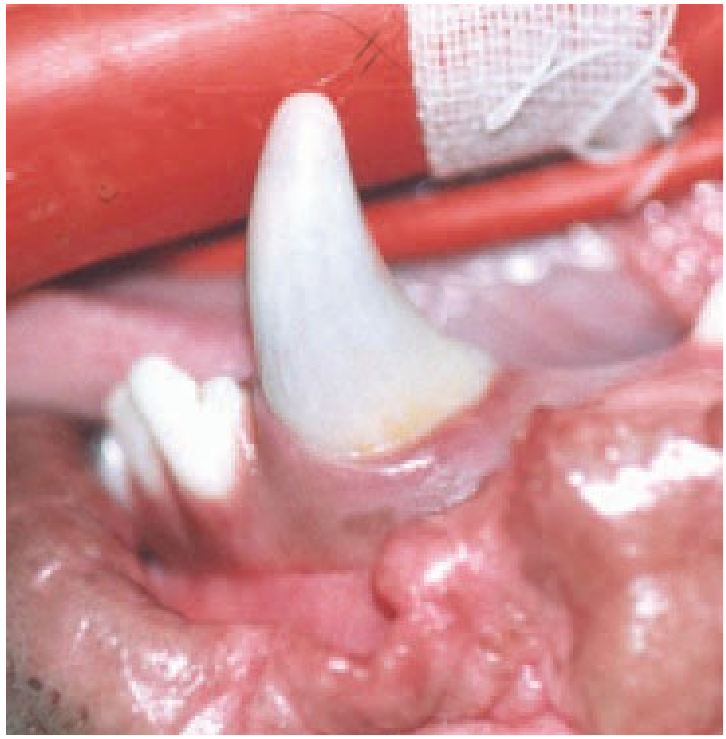

Figure 10.18 A necrotic pulp should be suspected in discoloured teeth. These teeth must be radiographed to evaluate periapical tissues.

Figure 10.19 Periapical pathology was radiographically confirmed and the access to the pulp chamber confirmed the presence of a necrotic pulp.

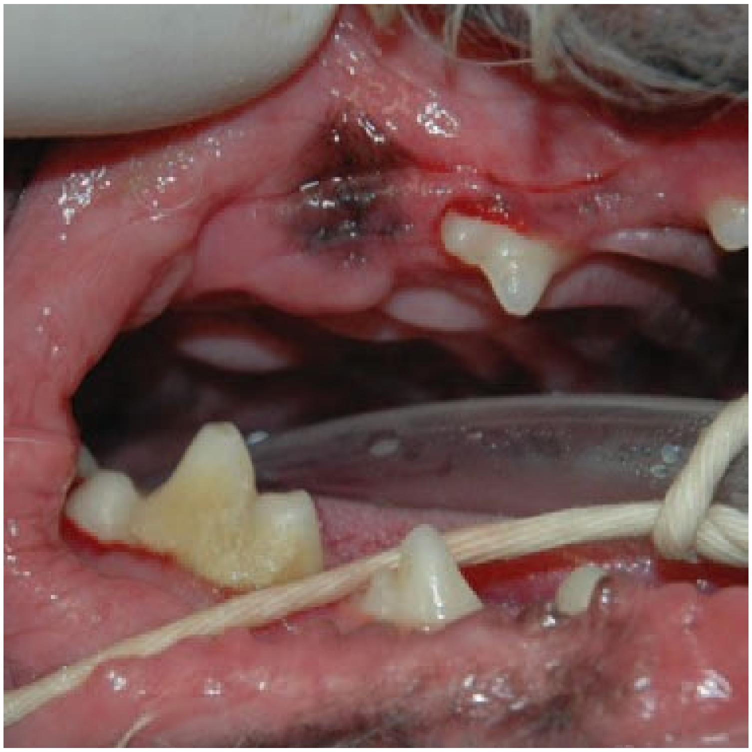

Figure 10.20 Remaining teeth may cause trauma to opposing teeth which may require crown amputation and root canal therapy.

was necrotic, and root canal therapy was performed on this tooth. When important teeth (canines and carnassials) are extracted, the occlusion of remaining teeth must be evaluated to ensure that they do not cause trauma to opposing tissues. In Figure 10.20 the mandibular right molar 1 is biting into the palatal mucosa. By shortening the crown sufficiently to prevent further trauma, the pulp chamber may be breached at one of the pulp horns. Radiography to determine the incisal extent of the pulp horns is essential. In the event that the pulp horns extend well into the crown, amputation to the required level should be performed followed by root canal therapy.

Further reading

Craig, R.G., Powers, J.M. and Wataha, J.C. (2000) *Dental Materials Properties and Manipulation* (7th edn). Mosby, St Louis, Missouri.

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11 Pain Management

When considering pain of dental origin in our patients, colleagues and pet owners alike too often respond with 'well he still eats and drinks so he can't be in much pain'. Dogs are pack animals where the hierarchy is usually strictly observed with a dominant pack leader. An otherwise healthy animal showing signs of pain may jeopardise its position in the pack.

After root canal therapy in a healthy dog with an exposed canine pulp canal, clients often report that their pet has begun to play with toys he had not played with since he broke his tooth. Owners of geriatric animals suffering from severe halitosis return for their pet's post-operative dental check-up reporting that the dog is acting like a puppy again. Although only anecdotal it would appear that these dental procedures are followed by marked changes in oral comfort, resulting in improved behaviour.

Some animals suffering from severe periodontal disease and those that have a malocclusion resulting in palatal trauma are often reluctant to have their mouths examined because of oral pain. The former often appear to associate pain with oral examination because of loose teeth which may obstruct mouth closure, while the latter inflict more pain on themselves as they tightly clench their teeth during attempts at oral examination. Maloccluding teeth often cause deep palatal lesions.

Let us assume that our patients experience pain to the same extent that we do and help them by relieving the pain as soon as we can.

Dental procedures whether as minor as routine prophylaxis treatment (scale and polish) or periodontal surgery to remove an epulis, or more involved procedures such as exodontics, all result in varying degrees of pain. We need to manage this in such a way that we keep our patients comfortable.

There are two sources of pain associated with dental surgery, namely acute pain associated with tissue damage such as surgery and secondary pain associated with inflammation. Dental pain is somatic pain. A-delta fibres (acute, sharp pain) and C fibres (secondary, throbbing pain) are mainly responsible for pain conduction.

Sensory nerve fibres recognise stimuli and when the number or intensity of stimuli reach a threshold an action potential results. The greater the intensity of the stimulus, the greater the number of action potentials, and the longer the duration of the stimulus, the longer the chain of action potentials.

Pre-emptive pain management ensures that pain cascades and action potentials are inhibited, leading to prevention of the wind-up phenomenon and a more comfortable patient in the post-operative period.

Dental prophylaxis may be considered to cause mild pain, while exodontics results in moderate to severe pain.

The use of multiple analgesics which have different actions helps reduce pain sensation.

There are four main analgesic groups:

- opioids
- non-steroidal anti-inflammatory drugs (NSAIDs)
- α-2 agonists
- local anaesthetics.

In selected cases ketamine infusion may be considered as an added mode of analgesia.

Opioids

Opioids relieve pain by binding with peripheral and central opioid receptors. Morphine and fentanyl are very effective mu-receptor blockers. Fentanyl is about one hundred times more potent than morphine but has a short-lived effect and must be delivered by constant infusion or cutaneous patch. Morphine treatment should be repeated at two- to four-hourly intervals. Buprenorphine (partial opioid agonist) is also an effective mu-receptor blocker which is repeated at six- to twelve-hourly intervals. These drugs can be used pre-, intra- and post-operatively.

Non-steroidal anti-inflammatory drugs (NSAIDs)

Carprophen and meloxicam are effective NSAIDs which can be administered pre-operatively to dogs undergoing dentistry and oral surgical procedures. Carprophen can be repeated at twelve-hourly intervals while meloxicam is repeated at 24-hourly intervals. Carprophen is only registered for a single parenteral dose in cats. Meloxicam can be repeated 24-hourly in cats. For dosage and specific instructions refer to the manufacturer's instructions.

Local anaesthesia and regional anaesthetic blocks

Local anaesthetic drugs usually have a high pKa (pH at which dissociation is at an equilibrium) but at physiological pH the cationic form is predominant. The uncharged base form readily crosses the nerve sheath where it dissociates and the charged cationic form has its effect. Local anaesthetics inhibit action potentials by blocking the sodium channels.

For the drug to be effective it needs to be at high concentrations in the uncharged base form to cross the membrane into the nerve.

Dissociation of local anaesthetic drugs is described by the formula:

$$BH^+ / B = 10^{(pKa-pH)}$$

or:

$$BH^+ = B \times 10^{(pKa-pH)}$$

Where BH^+ is the concentration of the cationic form (active form); B is the concentration of the uncharged base form (form in which the drug must be to pass into the nerve); pKa is the pKa value of the anaesthetic agent and pH is the pH of the tissue.

If the pKa of the anaesthetic agent is 8 and the pH of the tissue about 7, there will be ten times as much of the ionised form as of the unionised form. During inflammation the tissue pH decreases, let us say for example to 6; this will result in there being 100 times more ionised than unionised drug in the tissue (less of the uncharged base to pass into the nerve). In the ionised form the drug is unable to pass into the nerve and will therefore be ineffective. This accounts for local anaesthetics being ineffective in the presence of inflammation.

Table 11.1 lists the local anaesthetic agents commonly used in veterinary dentistry. Some surgeons prefer to use local anaesthetic agents which contain

Local anaesthetic	Dosage (total dose mg/kg body mass)	Onset of activity	Duration of activity (minutes)
Lidocaine	2.0	Rapid	60–120
Mepivacaine	2.0	Intermediate	90–180
Bupivacaine	2.0	Intermediate	180–240
Ropivacaine	2.0	Intermediate	180–240

Table 11.1 Local anaesthetic agents.

vasoconstrictive agents in order to reduce local haemorrhage and restrict the local anaesthetic agent to the area infused.

The injection sites for local / regional anaesthetic blocks commonly used in veterinary dentistry are shown in Figure 11.1. Table 11.2 lists the local anaesthetic sites and the regions anaesthetised by each injection.

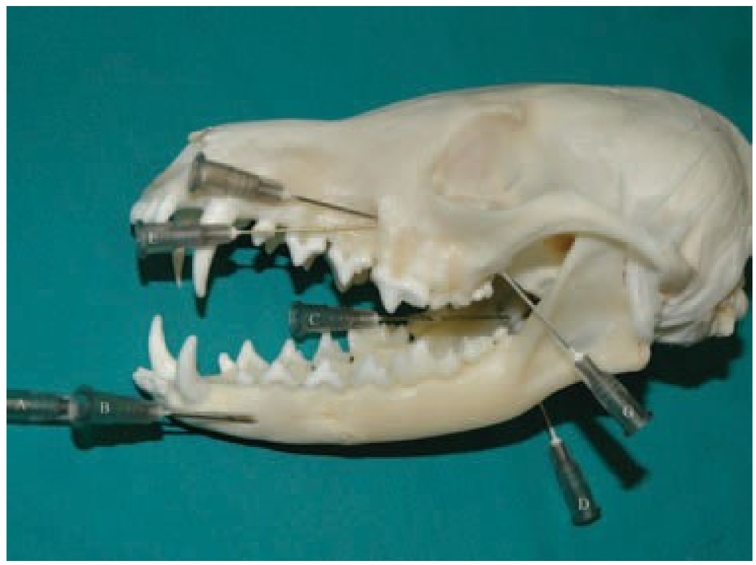

Figure 11.1 Local / regional anaesthetic delivery sites (see Table 11.2 for effects).
A: Superficial mental block.
B: Deep mental block.
C: Inferior alveolar nerve – intra-oral approach.
D: Inferior alveolar nerve – percutaneous approach.
E: Superficial infra-orbital block.
F: Deep infra-orbital block and maxillary block.
G: Maxillary block.

Block	Effect					
	Mental – superficial	Mental – deep	Mandibular	Infra-orbital – superficial	Infra-orbital – deep	Maxillary
Nerve blocked	Mental	Rostral inferior alveolar	Inferior alveolar	Infra-orbital	Middle and rostral maxillary alveolar	Maxillary
Region blocked	Ipsilateral lip, chin and rostral alveolar mucosa and gingiva	Ipsilateral lip, chin, gingiva, alveolar mucosa, canine and incisors	Ipsilateral mandible, teeth and soft tissues	Ipsilateral upper lip and alveolar mucosa rostral to PM4	Ipsilateral upper lip and alveolar mucosa, teeth rostral to and including PM4	Ipsilateral alveolar mucosa, gingiva, lips and teeth of maxillary quadrant
Teeth blocked	None	Ipsilateral canine and incisors	Ipsilateral mandibular teeth	None	Ipsilateral maxillary teeth rostral to and including PM4	Ipsilateral maxillary teeth

Table 11.2 Local anaesthesia and regional anaesthetic blocks.

Mental block

The superficial mental block is performed by inserting a 23 g (or smaller) hypodermic needle either just caudal to the labial frenulum or just rostral to the labial frenulum and advancing it beneath the frenulum, directing it towards the middle mental foramen. The latter is located in close proximity to the mesial root apex of the mandibular second premolar tooth. The neurovascular bundle can be palpated here in most medium to large breed dogs. With the bevel of the needle facing the mandible, the local anaesthetic is slowly infused after aspirating to rule out intra-vascular injection (Figure 11.2).

For the deep mental block the needle is advanced into the middle mental foramen from the rostral approach. With a finger placed over the foramen the local anaesthetic is very slowly injected into the rostral mandibular canal after aspiration. Rapid injection is to be avoided to prevent neuropraxia due to pressure within the canal (Figure 11.3).

Figure 11.2 The superficial mental block. The middle mental foramen is situated at about the apex of the mesial root of mandibular premolar 2. The needle is advanced to this point from a rostral or caudal direction and the local anaesthetic is injected after aspiration to ensure the needle is not intravascular.

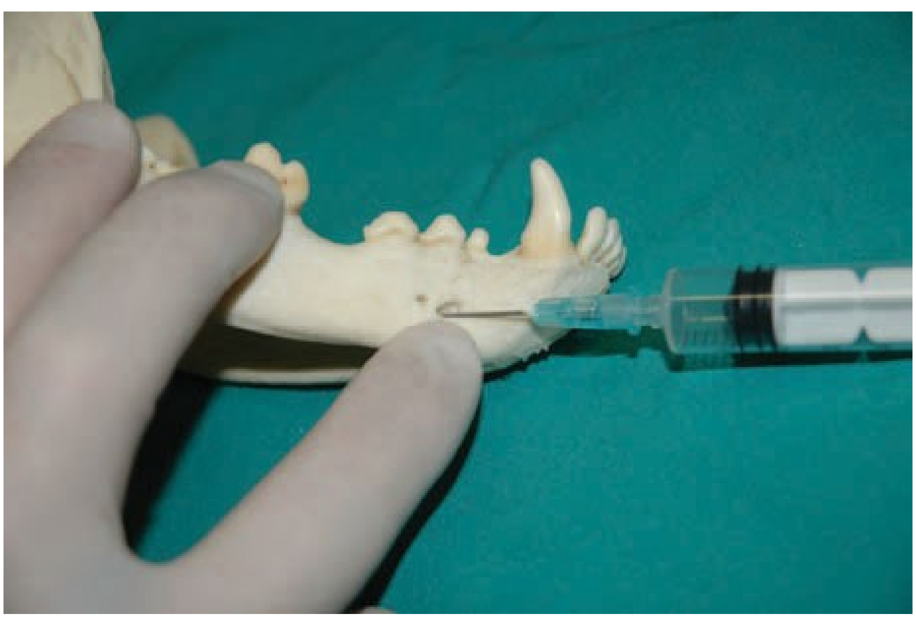

Figure 11.3 The deep mental block. In medium to large dogs the mental neurovascular bundle can be palpated caudal to the labial frenulum. The needle is advanced from the rostral aspect and inserted into the middle mental foramen. After aspiration an anaesthetic agent must be injected slowly to prevent neuropraxia as a result of pressure within the mandibular canal.

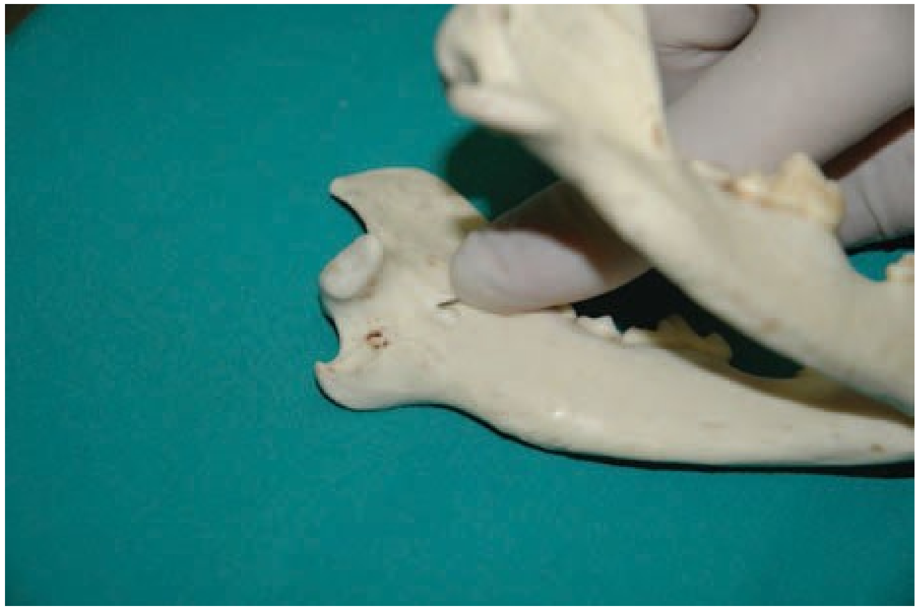

Figure 11.4 The mandibular block – intra-oral approach. The neurovascular bundle can be palpated intra-orally by sliding a finger along the medial aspect of the mandible halfway between the mandibular third molar and the angular process to where it enters the mandibular foramen. The needle is advanced submucosally until it reaches the mandibular foramen and after aspiration inject as described before. Gentle finger pressure over the needle will help restrict the anaesthetic to the area.

Mandibular block

The mandibular block can be administered intra-orally or percutaneously. Using either technique, the neurovascular bundle is palpated intra-orally at the mandibular foramen which is located lingually about mid mandible height, dorsal to the ventral margin, midway between the mandibular molar 3 and the angular process. When using the intra-oral route the needle is inserted through the lingual mandibular alveolar mucosa caudal to the mandibular second molar and advanced until it reaches the mandibular foramen (Figure 11.4). The needle bevel should face the mandible and digital pressure should be used to restrict the anaesthetic agent in close proximity to the neurovascular bundle. Aspiration should be performed prior to infusion. When using the percutaneous route, once the neurovascular bundle is identified intra-orally, the needle is advanced percutaneously just medial to the ventral margin of the mandible about halfway between molar 3 and the angular process and slowly advanced towards the mandibular foramen. Inject after aspiration (Figure 11.5).

Infra-orbital block

Digitally identify the infra-orbital neurovascular bundle in the region of the roots of the maxillary third premolar. Insert the needle through the buccal maxillary alveolar mucosa with the bevel facing the maxilla and advance the needle until it reaches the infra-orbital foramen. Aspirate before injecting (Figure 11.6).

The deep infra-orbital block is performed by advancing the needle into the infra-orbital canal to about half the width of the maxillary 4th premolar. Digital pressure at the infra-orbital foramen will restrict the anaesthetic to the canal. Aspirate before injecting (Figure 11.7).

Figure 11.5 The mandibular block – percutaneous approach. The neurovascular structures are identified as in Figure 11.4. The needle is inserted medial to the mandible halfway between the third molar and the angular process and advanced sub-mucosally to the mandibular canal. Proceed as in Figure 11.4.

Figure 11.6 The superficial infra-orbital block. Identify the infra-orbital neurovascular structures dorsal to the roots of the maxillary third premolar (a pulse can often be seen sub-mucosally). Advance the needle sub-mucosally until it reaches the infra-orbital canal. Aspirate and inject using digital pressure over the needle to restrict the anaesthetic.

Maxillary block

The maxillary block may be performed intra-orally or percutaneously. Performing the intra-oral route, the needle is advanced into the infra-orbital canal to the level of the maxillary molar 1 (Figure 11.8). Digital pressure is applied to the infra-orbital foramen and injection is performed as described above. The needle can also be inserted caudal to the maxillary molar 2 and directed towards the maxillary foramen.

Figure 11.7 The deep infra-orbital block. Proceed as in Figure 11.6. Insert the needle into the infra-orbital canal and advance it to about half the width of the maxillary 4th premolar. Aspirate and inject. Maintaining gentle digital pressure on the infra-orbital foramen will restrict the anaesthetic to the canal.

Figure 11.8 The maxillary block – intra-oral approach. Proceed as in Figure 11.7 but advance the needle to the level of maxillary molar 1. Apply digital pressure and aspirate and inject as before.

When using the percutaneous route the needle is placed in the angle formed by the zygomatic arch and the caudal maxilla just caudal to maxillary molar 2. The needle should be advanced in a rostro-medial direction aiming for the caudal opening of the infra-orbital canal (maxillary foramen) rostral to Tenon's capsule (Figure 11.9). Aspirate and inject as previously described.

Figure 11.9 The maxillary block – percutaneous approach. The needle is inserted in the angle formed by the zygomatic arch and the caudal maxilla, just caudal to the maxillary molar 2, and advanced in a rostro-medial direction aiming for the caudal opening of the infra-orbital canal (maxillary foramen). Aspirate and inject as before.
The needle can also be directed from an intra-oral approach, inserting the needle just caudal to the maxillary molar 2 and proceeding as described.

Further reading

Cornick-Seahorn, J.L. (2001) *Veterinary Anaesthesia*. Butterworth Heinemann, Woburn, MA.

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Small Animal Dentistry: A Manual of Techniques
Cedric Tutt

12 Malocclusions and Normal Occlusion

Figure 12.1 Brachycephalic dogs have short maxillae and many rotated teeth.

Normal occlusion for one breed may be considered abnormal for another. For example, the brachygnathic maxillae in Boxer dogs is considered abnormal in German shepherd dogs and golden retrievers.

Three head shapes are recognised:

(1) Brachycephalic, e.g. Bull dogs, Boxer dogs, Pugs etc. (Figure 12.1)

(2) Mesocephalic, e.g. German shepherd dogs, border collies, Labrador retrievers etc. (Figure 12.2)

(3) Dolichocephalic, e.g. greyhounds, rough collies, Shetland sheepdogs, Borzoi etc. (Figure 12.3)

In mesocephalic breeds the mandibles are slightly narrower and shorter than the maxillae resulting in what is termed anisognathic jaws. The mandibular incisors occlude with the cingula of the maxillary incisors (palatal aspect of the maxillary incisors) in a scissor bite (Figure 12.4). The mandibular canine fits evenly between the maxillary lateral incisor and canine with its lingual aspect occluding against the attached gingiva in the diastema between these maxillary teeth (Figure 12.5). The palatal aspect of the maxillary canine lies against the labial frenulum adjacent to the mandibular first premolar (Figure 12.6). The maxillary and mandibular premolars interdigitate, with the mandibular premolar 1 being most rostral (Figure 12.7). The premolars rarely occlude with each other.

The mesial and middle cusps of the mandibular molar 1 occlude palatal to the maxillary carnassial tooth. In some dogs the occluso-buccal part of the mesial cusp of mandibular molar 1 occludes with the palatal cusp of the maxillary carnassial tooth (Figure 12.8). The distal cusp of mandibular molar 1 occludes with the mesio-occlusal part of the palatal cusp of maxillary molar 1

Figure 12.2 Mesocephalic dogs have well proportioned heads with evenly spaced teeth.

Figure 12.3 Dolichocephalic dogs have long muzzles with increased inter-dental spaces between premolars.

(Figure 12.9). The mesio-occlusal part of mandibular molar 2 occludes with the distal part of the palato-occlusal cusp of maxillary molar 1 and the mesial part of the palato-occlusal surface of maxillary molar 2 (Figure 12.9). The mesio-occlusal part of mandibular molar 3 occludes with the distal

Figure 12.4 Scissor bite describes mandibular incisors which bite on the cingula (palatal aspect) of the maxillary incisors.

Figure 12.5 The mandibular canine fits evenly between the maxillary lateral incisor and canine. Often there is a small, even space between these three teeth.

Figure 12.6 The maxillary canine lies against the labial frenulum when the mouth is closed.

Figure 12.7 The premolar teeth interdigitate, with mandibular premolar 1 being most rostral.

Figure 12.8 Mandibular molar 1 occludes palatal to the maxillary carnassial tooth. In some animals the mesial cusp occludes against the palatal cusp of the maxillary carnassial tooth.

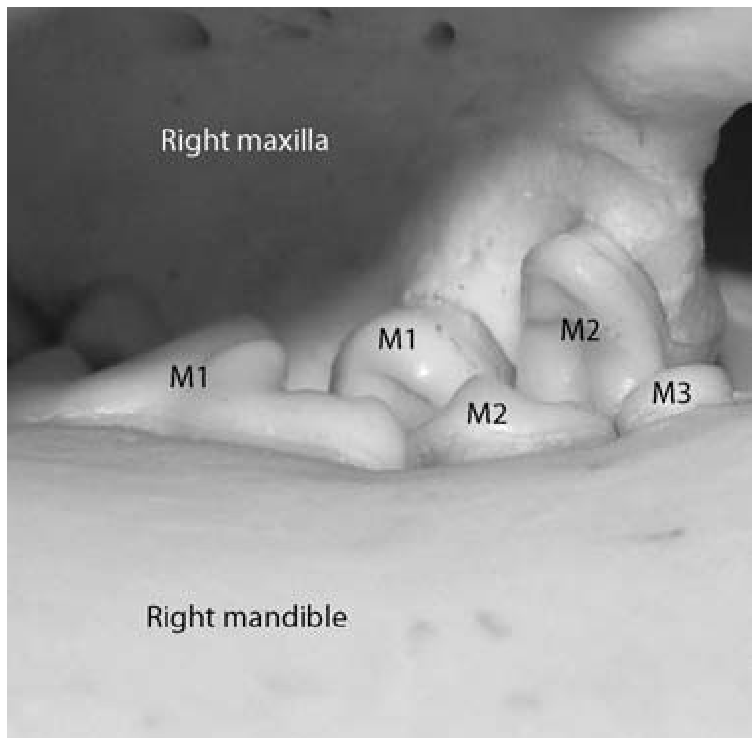

Figure 12.9 The distal cusp of mandibular molar 1 occludes against the mesio-occlusal part of the palatal cusp of maxillary M1. Mandibular M2 occludes against the palatal cusps of maxillary M1 and M2. Mandibular M3 occludes against the disto-palatal aspect of maxillary M2.

palato-occlusal surface of maxillary molar 2 (Figure 12.9). The buccal cusps of maxillary molars 1 and 2 partially overlap the mandibular molars 1, 2 and 3 buccally (Figure 12.10).

Brachycephalic animals may have a normal scissor bite but most will have either a reverse scissor bite (maxillary incisors caudal / lingual to mandibular incisors) similar to the dog in Figure 12.11 or the maxillary incisors will be situated at varying distances lingual to the mandibular incisors when the mouth

Figure 12.10 The buccal cusps of maxillary molars 1 and 2 partially overlap the mandibular molars 1–3 bucally.

Figure 12.11 Reverse scissor bite describes the situation where the maxillary incisors occlude lingual to the mandibular incisors. This is also known as a rostral cross-bite.

Figure 12.12(a) Premolars are often rotated in brachycephalic animals. This animal also has a supernumerary maxillary right premolar 1. The PM3 has a complicated crown fracture.

Figure 12.12(b) Crowded and rotated mandibular right premolars.

is closed. Inevitably, the premolars are rotated to varying degrees about their mesiodistal axes (Figure 12.12(a) and (b)). Premolars may be missing in some arimals (Figure 12.13). Severe crowding occurs in some animals (Figure 12.14). Instead of the fairly straight mandibular teeth alignment seen in mesocephalic

Figure 12.13 The mandibular right premolar 2 is missing.

Figure 12.14 These maxillary left premolars are crowded and overlap extensively.

and dolichocephalic breeds the teeth in the mandibular arcades of brachycephalic animals can be arranged in an S-shape (Figure 12.15). Bull dogs often have supernumerary incisors, but because of their wide incisive bones they go unnoticed (Figure 12.16). In some dogs the maxillary lateral incisors bite onto

Figure 12.15 Instead of being in a straight line, the mandibular cheek teeth of brachycephalic animals are often arranged in an S-shape.

Figure 12.16 This Bull dog's incisors are evenly spaced although there are four in the maxillary left quadrant.

the lingual aspect of the mandibular canines, causing attrition of both teeth and sometimes severe periodontal disease (Figure 12.17). In exaggerated maxillary brachygnathism the mandibles develop a ventral bow with the mandibular incisors protruding dorsally beyond the maxillary incisors (Figure 12.18) and the upper lip margin.

Figure 12.17 The defect lingually on the mandibular left canine is a result of malocclusion. The maxillary left lateral incisor has damaged the canine. The maxillary incisors have also traumatised the gingiva lingual to the mandibular incisor teeth.

Figure 12.18 In some brachycephalic animals the mandibles develop a ventral bow resulting in the mandibular incisors protruding dorsal to the maxillary incisors.

Dolichocephalic breeds have long muzzles which come to a rather sharp point. The incisors are usually in normal scissor occlusion but in some cases the maxillae are longer than the mandibles resulting in maxillary prognathism. The mandibular canines can impinge on the palate and in severe

Figure 12.19 Diastemata in dolichocephalic animals are sometimes so wide that it appears as though there are teeth missing

cases result in oro–nasal communication. Generally the interproximal (inter-tooth) spaces are enlarged and this gives the impression of gaps in the dentition (Figure 12.19).

Commonly seen malocclusions

It is important to remember that each jaw quadrant grows independently of the others and therefore a young animal's dentition can vacillate from normal to abnormal and back to normal again as it develops. Under most conditions the mandibles grow at the same pace but their growth appears to alternate with that of the maxillae which also usually both grow at the same pace.

When deciding whether an animal is suffering from a short lower jaw or long upper jaw it is also important to evaluate the relationship of the premolars and not only the canines and incisors (Figure 12.20). Figure 12.21 shows normal premolar interdigitation.

If a single tooth or a couple of adjacent teeth are out of alignment the condition is likely to be as a result of a traumatic incident and these teeth or the adjoining teeth often show signs of enamel damage (Figure 12.22 (a) and (b)). This is a dental malocclusion. If numerous teeth are out of alignment the condition is most likely due to a genetic predisposition which is inevitably heritable. This is a skeletal malocclusion. Siblings may have similar dental conditions (Figures 12.23 and 12.24) but often only one pup or kitten per litter manifests a malocclusion.

Figure 12.20 When evaluating jaw length discrepancies it is important to examine the premolar occlusion. The maxillary and mandibular premolars should interdigitate. In this dog the maxillary and mandibular right second premolars are in tip-to-tip occlusion, an indication of a malocclusion.

Figure 12.21 Normal premolar interdigitation.

Mandibular brachygnathism

If the mandibles are shorter than the maxillae and the maxillary teeth are evenly spaced one would define the condition as mandibular brachygnathism rather than maxillary prognathism. Animals with mandibular brachygnathism

Figure 12.22 (a) Malocclusions which affect one or more adjacent teeth, some of which may have evidence of trauma, are called dental malocclusions.

Figure 12.22 (b) The mandibular right canine has become displaced by biting against the damaged maxillary right lateral incisor which has been partially intruded (see Figure 12.22 (a)). The persistent 704 (deciduous mandibular left canine) was an incidental finding.

often have mandibular canine malocclusion resulting in trauma to the maxillary gingiva or palatal soft tissues (Figure 12.25). This condition is seen in many breeds, e.g. bearded collies, border collies, German shepherd dogs, Dachshunds, Scottish terriers (Wheaten coloured Scottish terriers appear to

Figure 12.23 Palatal trauma is due to maloccluding mandibular canine teeth.

Figure 12.24 Very similar lesions in this animal – a litter mate of the dog in Figure 12.23.

be well represented) and English bull terriers. If left untreated the canine can form an oro–nasal fistula.

Some breeds, with normal incisor scissor bite, have mandibular canines which are more upright than normal and which impinge on the palatal soft

Figure 12.25 Deep palatal mucosa defects can become oro–nasal fistulas.

Figure 12.26 Linguo-verted mandibular canines in an English bull terrier.

tissues, e.g. English bull terrier and border terrier. These teeth are termed linguo-verted mandibular canines (Figure 12.26). In these patients the diastema between maxillary lateral incisor and canine can become obliterated as the incisive bones tip ventro-caudally under the pressure of the upper lip (the lower canine not maintaining the diastema) (Figure 12.27).

Figure 12.27 The ostral maxillary left quadrant of the dog in Figure 12.26. Note that the canine – lateral incisor diastema has been obliterated by the caudo-ventral tipping of the incisive bones. This is as a result of pressure from the upper lip.

Figure 12.28 Deep gingival ulcers in the canine–lateral incisor diastema caused by mandibular deciduous canine teeth result in pain and reluctance on the part of these animals to have their mouths examined.

Young puppies with undiagnosed mandibular brachygnathism may have deep holes in their maxillary gingiva (Figure 12.28) or palatal soft tissues caused by maloccluding deciduous canines. These lesions often expose the bony hard palate and bleed on probing. Dorso-ventral intra-oral radiographs

may reveal a marked periosteal reaction on the bony hard palate in association with the palatal soft tissue injuries. These patients are reluctant to have their mouths examined as it appears that clenching their teeth during attempts at examination causes severe pain. Mandibular canines, when deeply embedded in the palatal soft tissues, inhibit longitudinal jaw growth and the mandibles often develop a ventral bow in compensation.

Extraction of the deciduous canines is the treatment of choice and is known as interceptive orthodontics as it allows any remaining potential mandibular elongation to occur. An added advantage of extracting these teeth is that it reduces the likelihood of linguo-verted permanent canines as there is now space for them to move into their normal position.

Animals presented with mandibular brachygnathism who have permanent teeth causing palatal trauma will require one of three treatments: the canines should be moved (requiring orthodontic treatment (Figures 12.29–12.32)),

Figure 12.29 Maloccluding mandibular canine teeth can be moved into their normal position using an inclined plane made *in situ*. A figure-of-eight wire is placed around the maxillary canines and held in place by restorative material ledges bonded to the teeth buccally. In this case, blue restorative material is used to differentiate it from tooth substance when the inclined plane is removed.

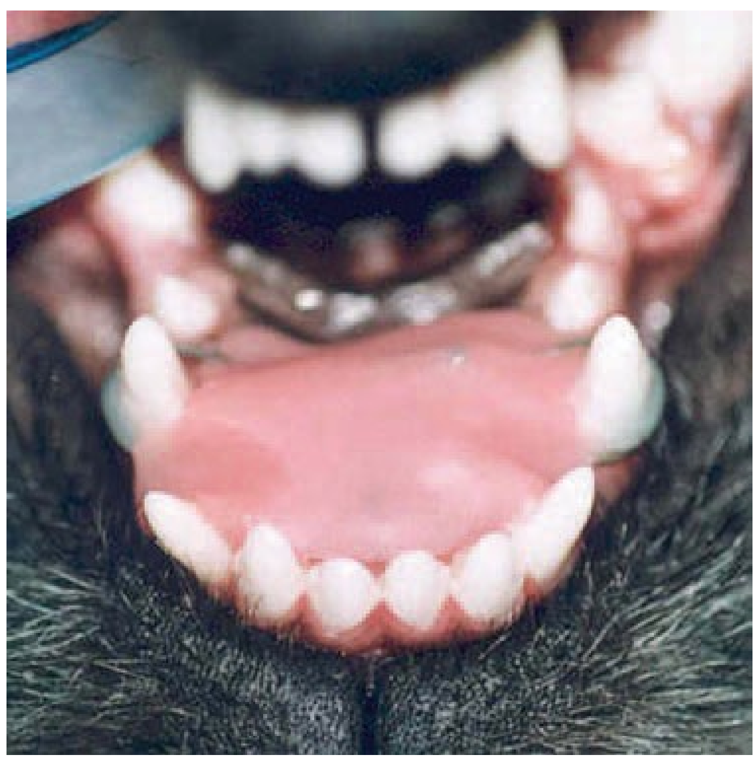

Figure 12.30 The inclined plane with 'tracks' to direct the teeth into their normal position.

Figure 12.31 Before the animal is awoken, the ET tube is removed and the jaws closed, to ensure that both mandibular canines engage the inclined plane. If only one tooth engages the plane the jaw can shift to the side where the tooth is engaged but will not result in orthodontic movement.

Figure 12.32 Once the teeth have moved into the desired position the inclined plane should be kept in place for a further two to three weeks to act as a retainer in order to allow new bone to fill in on the lingual aspects of the mandibular canines otherwise they may tip back lingually.

shortened (requiring endodontic treatment (Figure 12.33)) or extracted. Extraction of immature teeth (teeth in which root apices have not yet developed) can be challenging and it is possible that remnants of the developing root may remain.

Figure 12.33 Another option in the treatment of maloccluding mandibular canine teeth is crown amputation and root canal therapy. These teeth were amputated to the level of the lateral incisor giving the animal a functional and comfortable bite.

Figure 12.34 Reverse scissor bite may be seen in animals with an otherwise normal occlusion.

Reverse scissor bite – a severe form of anterior cross-bite

The reverse scissor bite can be associated with an otherwise normal occlusion (Figure 12.34) or seen in animals with prognathic mandibles (Figure 12.35) or in brachycephalic breeds.

Figure 12.35 An exaggerated reverse scissor bite in a dog with prognathic mandibles.

Figure 12.36 Rostral cross-bite with some incisors in reverse scissor bite and others in scissor bite.

Rostral cross-bite

This describes the malocclusion where some mandibular incisors are in reverse scissor bite while the others are in normal scissor occlusion (Figure 12.36) or all mandibular incisors may be in reverse scissor bite. It is usually unnecessary

Figure 12.37 Candal cross-bite. The maxillary third premolar is occluding palatal to the mandibular 4th premolar.

to treat these patients but if there is tip-to-tip occlusion or soft tissue damage the offending teeth should be extracted. Although orthodontics may be a possible treatment it is rarely performed.

Candal cross-bite

This describes the malocclusion where the mandibular premolars and sometimes mandibular molar 1 occlude buccal to the maxillary teeth (Figure 12.37). If the animal has a comfortable and functional bite no treatment is indicated. However if there is discomfort or trauma due to the malocclusion, the offending teeth should be extracted. Orthodontics is usually not indicated in these cases. The normal physical cleansing of the mandibular molar tooth by the maxillary carnassial does not occur and therefore the mandibular molar accumulates plaque and calculus which will require more regular professional treatment. Once treated, the client should be able to keep the teeth clean using dental home care techniques.

Wry bite

This describes the malocclusion resulting from the patient having a crooked face. This may be congenital or as a result of trauma (Figure 12.38). The incisors in these cases are often in an 'open-bite' where they do not occlude.

Some dental malocclusions can obstruct the jaws from closing and interfere with mastication. In these cases the tooth of lesser importance should be sacrificed and extracted to create a functional and comfortable bite (Figure 12.39 (a) and (b)).

Supernumerary teeth often do not cause problems but when they do they should be extracted. Indications for extraction of supernumerary teeth

Figure 12.38 Wry bite. This animal had a maloccluding mandibular right canine which was ‘trapped’ in the palatal mucosa inhibiting longitudinal growth of the right mandible. Consequently the mandibular right incisors and canine are positioned caudal to their left counterparts.

Figure 12.39(a) Dental malocclusion inhibiting jaw closure. The mandibular left canine is biting against the maxillary left lateral incisor, resulting in an ‘open-bite’.

include trauma and pain and inflammation caused by the extra teeth and existing or potential compromise of the normal dentition (Figures 12.40–12.42). Some supernumerary teeth appear normal and do not cause problems and can therefore be maintained in the mouth (Figures 12.43 and 12.44).

Figure 12.39(b) The tooth of lesser importance (maxillary left lateral incisor) was extracted, enabling this dog to close its mouth and have a comfortable and functional bite.

Figure 12.40 'Supernumerary' teeth should be radiographed before a decision is made to extract any, as some may be persistent deciduous teeth, as in this mandibular left persistent deciduous lateral incisor.

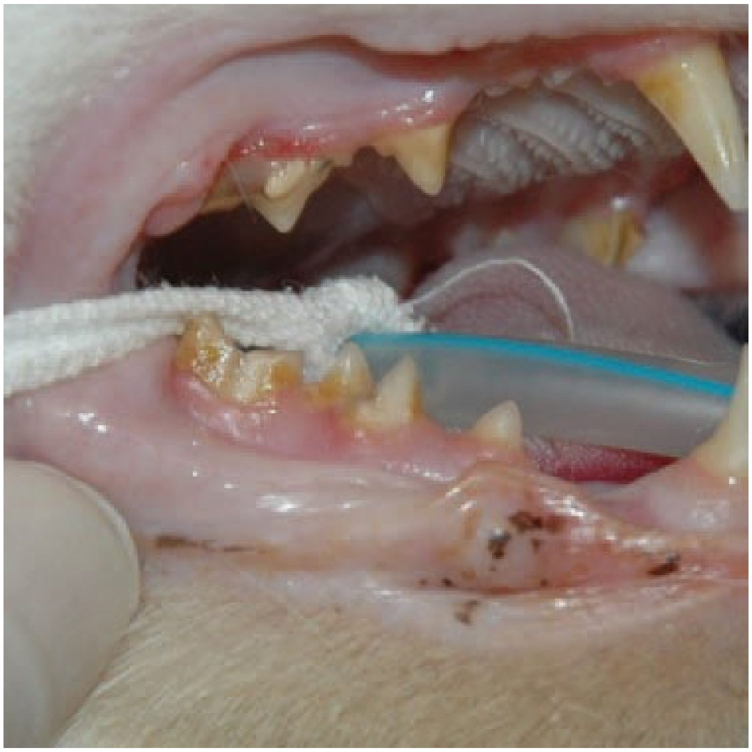

Figure 12.41 Crowding of teeth often leads to failure of the normal tooth : tooth cleansing mechanism.

Figure 12.42 Crowding has exacerbated periodontitis in this cat.

Figure 12.43 The incisors are well spaced in this dog even though there is a supernumerary maxillary left middle incisor (202). The dog was presented for treatment of the fractured maxillary right middle incisor (102).

Figure 12.44 This supernumerary maxillary left premolar 1 is not compromising any other teeth and can be maintained in the mouth.

Figure 12.45 Malaligned teeth can be unsightly but there is no need to extract any teeth in this case.

Figure 12.46 This cat has a similar incisor pattern to the dog in Figure 12.45 and does not need any teeth extracted.

Malaligned teeth may be unsightly but if they are not crowded or causing trauma they should be maintained in the mouth (Figures 12.45 and 12.46).

Some malocclusions are functional and painless and therefore the offending teeth can be maintained in the mouth (Figures 12.47 (a) and (b)–12.49).

Figure 12.47 (a) This dog has severely brachygnathic mandibles but a comfortable bite. The mandibular canines have created a gingival defect into which they fit on each side.

Figure 12.47 (b) Ventral view of the dog in Figure 12.47 (a).

Figure 12.48 This Jack Russell terrier has its mandibular left canine distal to the maxillary canine instead of mesial to it. The maxillary canine has been moved mesially closing the normal diastema into which the mandibular canine should have fitted.

Figure 12.49 This Dachshund has a comfortable bite even though the mandibular canines are palatally displaced. The canines have formed shallow mucosal defects on the palate and are no longer erupting. The palatal lesions will be monitored long term and odontoplasty or crown amputation performed if required.

Further reading

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Small Animal Dentistry: A Manual of Techniques
Cedric Tutt

13 Cases to Refer to Your Local Veterinary Dentist

Congenital cleft palate (Figure 13.1).

Figure 13.1 Congenital cleft palate. Careful planning is necessary before surgery is undertaken in these patients as the first attempt at repair has the best prognosis.

Acute oro–nasal communication or chronic oro–nasal fistulation (Figure 13.2).

Figure 13.2 Chronic oro–nasal fistula. These defects can be repaired using a single- or double-flap technique. When multiple attempts have been made at their repair the prognosis for complete healing deteriorates.

Avulsed teeth (Figure 13.3 (a)).

Figure 13.3(a) Avulsed teeth may still be attached to the gingiva or may be carried to the practice by the client. Teeth that are avulsed and out of the mouth should be transported in a receptacle containing milk to prevent the ligament fibres from desiccating.

Luxated teeth (Figure 13.3 (b)).

Figure 13.3(b) This mandibular right canine is luxated with the buccal alveolus still attached to the tooth.

Teeth requiring crown elongation procedures (Figure 13.4).

Figure 13.4 Crown elongation techniques including an apically repositioned flap will need to be performed on this tooth prior to root canal therapy and restoration.

Teeth requiring endodontic therapy (Figure 13.5).

Figure 13.5 Root canal treatment is indicated in discoloured teeth with necrotic pulps.

Patients requiring prosthodontics, including crown placement (Figure 13.6).

Figure 13.6 'Wire-biter' patients can have three-quarter jacket crowns fitted to protect the teeth, but behavioural therapy will also be required to stop the habit.

Patients with malocclusion requiring orthodontic treatment (Figures 13.7 and 13.8).

Figure 13.7 This patient had mandibular malocclusion with the canines biting into the palatal mucosa. Orthodontic treatment is appropriate but removal of the animal from breeding programs is essential to prevent transmission of the 'skeletal malocclusion genes'.

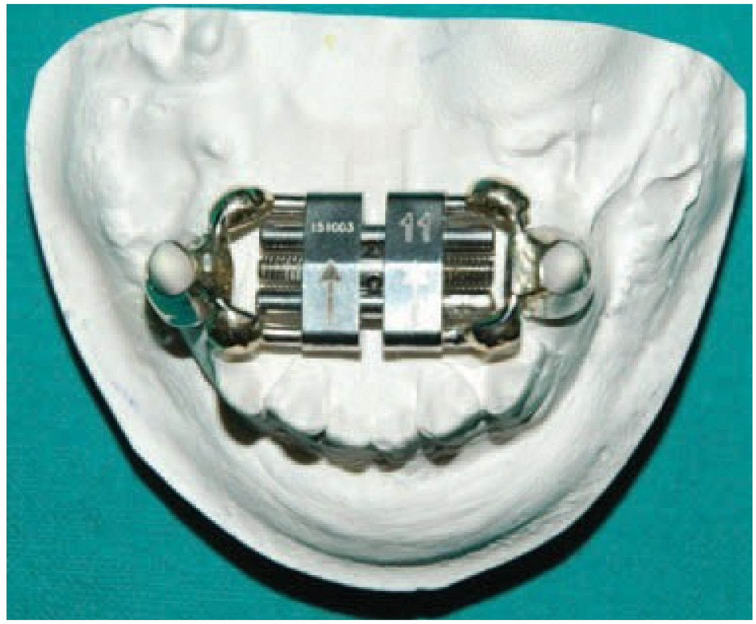

Figure 13.8 This 'distracter' was manufactured for the patient in Figure 13.7.

Patients requiring oral surgery, including tumour resection (Figure 13.9).

Figure 13.9 Patients with oral tumours may also be referred to those colleagues with expertise in dentistry and oral surgery.

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